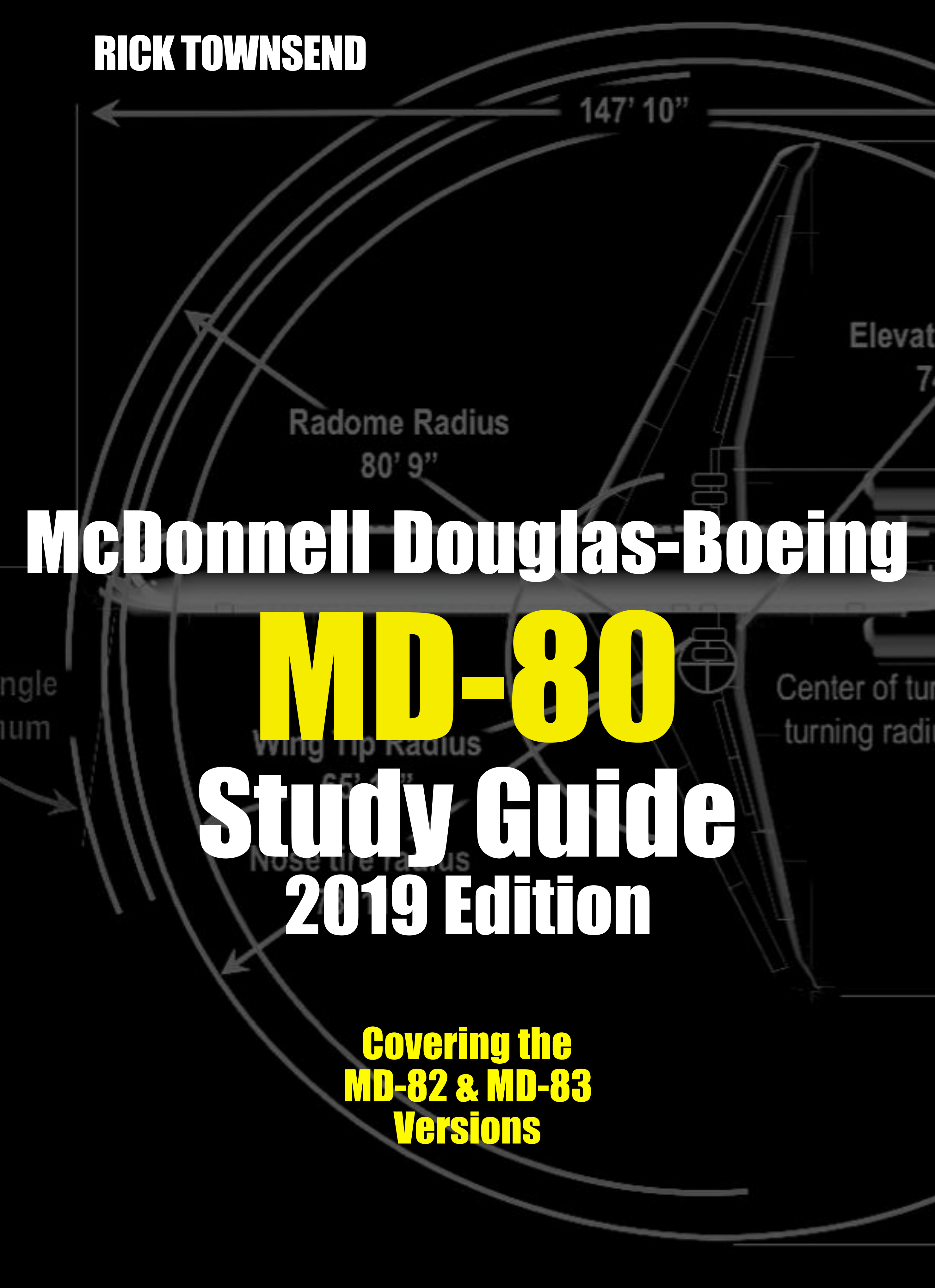
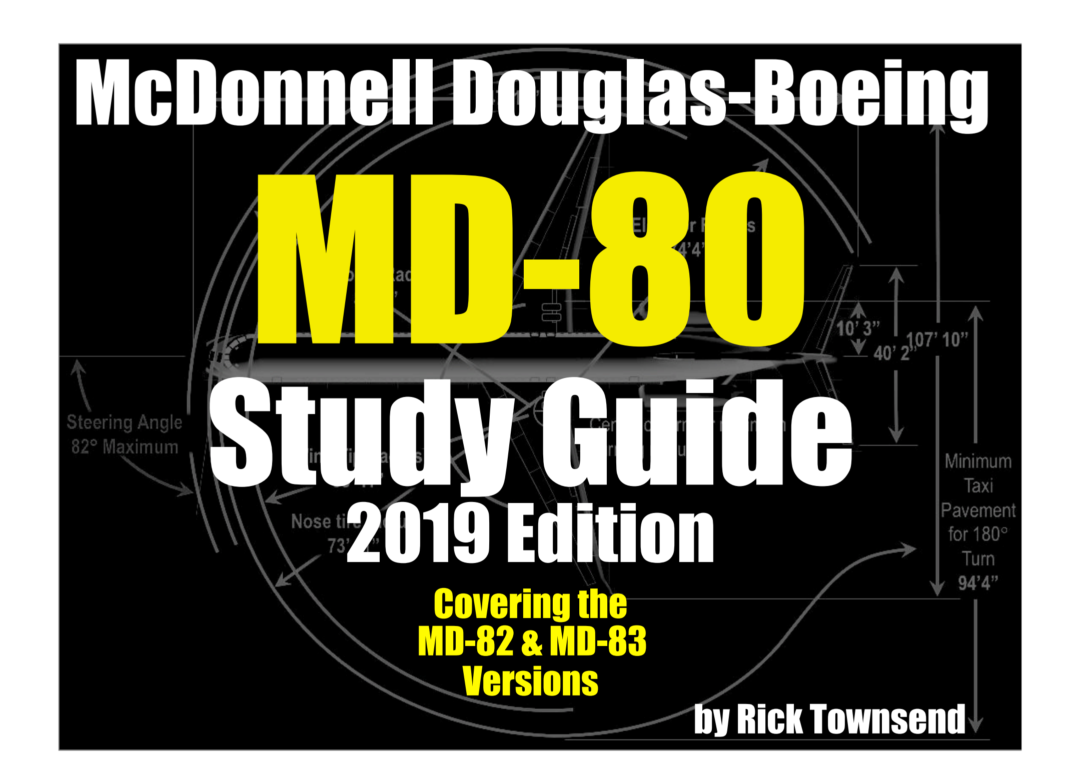


RICK TOWNSEND

McDonnell Douglas-Boeing MD-80 Study Guide

2019 Edition

Covering the MD-82 & MD-83 Versions



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As a courtesy to the pilots of American Airlines who have supported the development of these books, it is noted that this edition is current to the best ability of the author to make it so, and includes material relevant to:

QRH Revision 17, Temporary Revision — None
Flight Manual Volume I Revision 101, Temporary Revision — None
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Introduction

What This Book IS

This Study Guide is a compilation of notes taken primarily from the flight manual, but also includes elements taken from class notes, computer-based training, and operational experience. It is intended for use by initial qualification crewmembers preparing for orals, and also for systems review prior to recurrent training or check rides. It is assembled in an attempt to organize in one location all the buzz words, acronyms, and numbers the average pilot needs to know in order to get through the events above from an aircraft systems standpoint.

What this Book IS NOT

It is not officially sanctioned by American Airlines, and the author assumes all responsibility for accuracy. (Forward corrections to the address provided, please!) It does not replace study of the operations manual, but instead provides a supplementary source of review material to complement study of official publications. Except for a few specific areas, Except for a few operational issues, it does not include Flight Manual Part 1, or other materials—just airplane systems details, some ideas for organizing the cockpit flow, cold weather operations, etc. The Study Guide is not printed on fancy paper or expensively bound. That makes it easy to tuck into your kit bag or briefcase and study as you travel. Therefore, for these same reasons, it is far less expensive than most commercially produced books of its kind. It is intended to be affordable and usable.

Suggested Uses

A good time to use this book is on layovers. A reasonable plan would be to attempt to review limitations, memorization Red Box items once per sequence, and the rest of the sections once per month. Reviewing sectional study outlines usually leads to trying to remember one of those great plumbing diagrams from the flight manual or synoptics, and so those also get reviewed in the process.

Limitations and Black Border items are laid out so that you may cover the answer with a 3x5 card and quiz yourself. Other sections are in outline form.

A word about acronyms—you will probably see most of the acronyms you have heard of before in this book, as well as a few new ones. Most of us avoid them when possible, using clues on aircraft instrument and systems management panels to jog our memories. But for those you have trouble with, I've included all the ones I could think of. It is not necessary to learn all of them, but only those you need to use to help remember tough sets of items. Thankfully, the fleet management folks believe in keeping these "laundry lists" to a minimum, so you will see fewer of these than you will likely have seen in previous aircraft types.

Unique Formatting Features

Throughout this book, several specific methods are used to highlight information. They include:

Recommended memorization sections

Material highlighted in a light blue box represents topics that are frequently discussed on orals or which simply need to be known without reference to the books. This highlighting is found in systems notes, but not in the limitations section, which all requires a high level of retention. Please let me know of any recommendations you may have for other information that should be included in this category.

Master Caution and **Master Warning** lights are Indicated by highlighted **MC** (Master Caution) and **MW** (Master Warning) highlights within this Guide.

Panel or Warning Light Text—Words or indications found on system panels or switches is indicated by bold, all capital letters such as **LOW PRESSURE.**

Material that applies only to former TWA airplanes is set off in a box like this one, with the TWA code in the lower right corner of the affected box .... **TWA**

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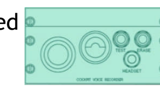
Table of Contents | Overhead Panel | Fwd Panel Ctr Console

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Again, please send me any suggestions or corrections using the contact information below:

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Revisions

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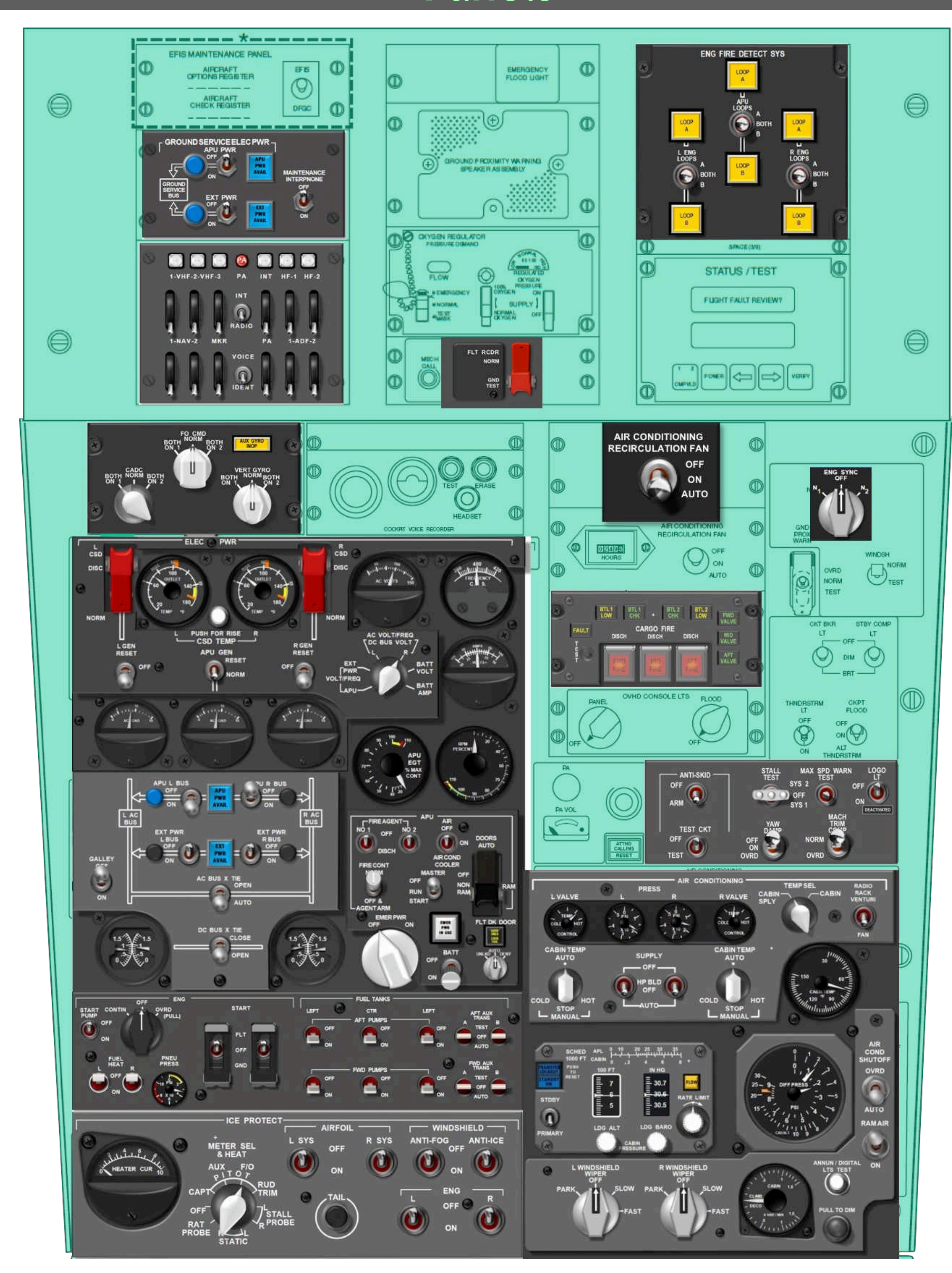
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Panels



EFIS MAINTENANCE PANEL
AIRCRAFT OPTIONS REGISTER
AIRCRAFT CHECK REGISTER
EFIS
DFGC
EMERGENCY FLOOD LIGHT
GROUND PROXIMITY WARNING SPEAKER ASSEMBLY
ENG FIRE DETECT SYS
LOOP A
LOOP B
APU LOOPS
BOTH
L ENG LOOPS
R ENG LOOPS
GROUND SERVICE ELEC PWR
APU PWR
OFF
ON
EXT PWR
GROUND SERVICE BUS
MAINTENANCE INTERPHONE
APU PWR AVAIL
EXT PWR AVAIL
1-VHF-2-VHF-3
PA
INT
HF-1
HF-2
RADIO
1-NAV-2
MKR
1-ADF-2
VOICE
IDENT
OXYGEN REGULATOR
FLOW
EMERGENCY
NORMAL
SUPPLY
FLT RCDR
NORM
GND TEST
MECH CALL
STATUS / TEST
FLIGHT FAULT REVIEW?
POWER
VERIFY
FD CMD
NORM
BOTH ON 1
BOTH ON 2
AUX GYRO INOP
CADC
VERT GYRO
TEST
ERASE
HEADSET
COCKPIT VOICE RECORDER
AIR CONDITIONING RECIRCULATION FAN
AUTO
HOURS
ENG SYNC
GND PROX WARN
WINDSH
OVRD
ELEC PWR
L CSD
R CSD
DISC
PUSH FOR RISE
CSD TEMP
L GEN RESET
R GEN RESET
APU GEN
RESET
AC VOLT/FREQ
DC BUS VOLT
EXT PWR VOLT/FREQ
BATT VOLT
BATT AMP
APU
AC VOLTS
FREQUENCY
AC LOAD
BTL 1 LOW
BTL 2 LOW
CARGO FIRE
DISCH
FAULT
FWD VALVE
MID VALVE
AFT VALVE
OVHD CONSOLE LTS
PANEL
FLOOD
CKT BKR LT
STBY COMP LT
DIM
BRT
THNDRSTRM LT
CKPT FLOOD
ALT THNDRSTRM
PA VOL
ATTND CALLING RESET
ANTI-SKID
ARM
TEST CKT
STALL TEST
SYS 2
SYS 1
MAX SPD WARN TEST
LOGO LT
YAW DAMP
MACH TRIM COMP
APU L BUS
APU R BUS
L AC BUS
R AC BUS
EXT PWR L BUS
EXT PWR R BUS
GALLEY
AC BUS X TIE
OPEN
DC BUS X TIE
CLOSE
FIRE AGENT
NO 1
NO 2
AIR
DOORS AUTO
AIR COND COOLER
FIRE CONT
MASTER
RUN
START
NON RAM
RAM
EMER PWR
FLT DK DOOR
BATT
APU EGT % MAX CONT
RPM PERCENT
AIR CONDITIONING
PRESS
L VALVE
R VALVE
TEMP SEL
CABIN SPLY
CABIN
RADIO RACK VENTURI
FAN
CABIN TEMP AUTO
SUPPLY
HP BLD OFF
COLD
HOT
STOP
MANUAL
ENG
START PUMP
CONTIN
OVRD (PULL)
FUEL HEAT
PNEU PRESS
FLT
GND
FUEL TANKS
LEFT
CTR
AFT PUMPS
AFT AUX TRANS
FWD PUMPS
FWD AUX TRANS
SCHED 1000 FT
FLOW
STDBY
PRIMARY
LDG ALT
LDG BARO
RATE LIMIT
DIFF PRESS
AIR COND SHUTOFF
RAM AIR
ICE PROTECT
HEATER CUR
METER SEL & HEAT
AUX
F/O
CAPT
PITOT
RUD TRIM
STALL PROBE
RAT PROBE
STATIC
AIRFOIL
L SYS
R SYS
TAIL
WINDSHIELD
ANTI-FOG
ANTI-ICE
L WINDSHIELD WIPER
R WINDSHIELD WIPER
PARK
SLOW
FAST
ANNUN / DIGITAL LTS TEST
PULL TO DIM



Notes:

- ♦ Areas in tinted green are not depicted graphically in this book, but are shown for orientation.
- ♦ Electronic version: Touch the colored panel to jump to the page with that system and panel description.

Limitations

This Section is laid out for study with system areas on one side and the appropriate limitation on the other, so you can cover the answer with an index card and quiz yourself. Some of the limitations in Section 2 are not often encountered, such as alternate fuel limitations. For that reason, they have been shortened here for study. These will be listed in the left column, so that as you study, you will be reminded the limitation exists in the book and will (hopefully) think to look there should the situation be encountered. The Limitation column contains only a reminder to check the Ops Manual for the item in question.

Items formatted with green background are from other sections of the operating manual or flight manual Part 1. They are included in this section for ease of study. References for these items are provided.

Items outlined in a dashed box like this are ones which are required to be memorized. The rest need only be learned to a familiarity level.

General Limitations

Instrument Limit Markings (AFM)

Maximum and Minimum Limits:	Red Radial Line
Maximum Limits for Normal Takeoff (Engine N_1, N_2, and EGT):	Orange Radial Line
Precautionary Ranges:	Amber Arc
Normal Operating Ranges:	Green Arc

Engine Display Panel **TWA**

Maximum Limits (N_1, N_2 & EGT Only):	Red Radial / Arc and flashing digits
Maximum Limit Range Normal Takeoff (N1, N2 & EGT Only):	Orange Radial / Arc
Precautionary Range (EGT Only):	Amber Arc
Normal Operating Ranges:	Green Arc

Systems Display Panel **TWA**

Maximum Limits (Oil Temp Only):	Red Annunciator Light
Maximum Limits (Oil Pressure Only):	Flashing digits
Minimum Limits (Oil Pressure Only):	Red Annunciator Light
Precautionary Ranges (Oil Temperature, Pressure, Hydraulic Quantity Only):	Amber Annunciator Light

Wing Landing Light Cooling — After Initial Extension:	1 ½ minutes before next activation (motor cooling)
After Subsequent Extensions:	3 ½ minutes before subsequent activation (motor cooling)
Max Lamp On Time in Ambient, Still Air:	10 Minutes

Operational Limitations

Flight Maneuvering Load **Acceleration Limits (AFM)**

Flaps Up:	+2.5 to -1.0 G
Flaps Down:	+2.0 to -0.0 G

Operational Limits **(AFM)**

Takeoff Runway Slope:	+1.7% to -2.0%
Landing Runway Slope:	+2.0% to -2.0%

Maximum Wind Limits**—Takeoff and Landing**

Tailwind (AFM):	10 Knots (May be further limited by performance requirements)
Crosswind (Max demonstrated):	30 Knots (Maximum demonstrated is not an AFM Limit)

Landing—Crosswind Limits **(Including gusts)** Runway (AA Policy)

Dry (Max Demonstrated):	30 Knots
Braking Action Fair:	20 Knots
Braking Action Poor:	10 Knots
Visibility — Less than ¾ Mile (RVR 4000' or 1200 Mtrs):	15 Knots — OM Vol. I APP-LDG-G/A, p. 30.5, 35.1, 45.2

Braking action must be determined by ATIS, PIREPs, tower reports or environmental conditions including wet runway, standing water, slush, snow or ice.
Tailwind allowance may be further reduced by performance requirements

Automatic Landings

Headwind:	25 Knots (Reference 1)
Tail Wind:	10 Knots (Reference 1)
Crosswind:	15 Knots (Reference 1)

OM Vol. I APP-LDG-G/A 40.3

Other Wind Limits

RUDDER TRAVEL UNRESTRICTED Light not on during Approach:	12 Knots — QRH, Emergency Sec., FLT-C 16
Maximum Wind Gust:	50 Knots, except in emergency — FM Part 1, p.10-22 & 12-3,& OM Volume I, p. APP-LDG-G/A-45.2
Runway Width < Standard (148'/45 Meters):	20 Knots — FM Part 1, pages 6.1-9
Restricted Captain (FAA Exemption 5549):	10 Knots — FM Part 1, section 10, page 14

Altitudes

Minimum T/O & Landing Altitude (AFM):	-1000 Feet
Maximum T/O & Landing Altitude (AFM):	8500 Feet
T/O & Landing Temperature Limits (AFM):	-54°C to +50°C (-65°F to +122°F)
T/O, Landing, & Enroute OperationalLimits:	Environmental Envelope Chart, p. LIM 5 ➔
Inflight Maximum Altitude:	FL 370

Environmental Envelope

Pressure Altitude; 40,000; 30,000; 20,000; 10,000; 0; FL370; Enroute Operational Limits; 8500 feet; Takeoff and Landing Operational Limits. Airport Altitude and Ambient Temperature; -1,000 feet; -80 -60 -40 -20 0 +20 +40 +60 °C

Airspeed

General — Airspeed limitations are given in both airspeed and mach number. *The limiting value is the lower of the two. Altitude determines which value will be lower.*

Maximum Operating Speed — V_{MO}: 340 Knots; M_{MO}: .84 M. *Maximum operating limit speed V_{MO} / M_{MO} may not be deliberately exceeded in any regime of flight (climb, cruise, descent).*

Design Maneuvering Speed: Turbulence penetration speed *is a rough approximation. See notes, p. LIM 10.8. No specific numbers identified for memorization*

Landing Gear Operation:

Extension (V_{LO}/M_{LO}):	300 Knots or .70M
Retraction (V_{LO}/M_{LO}):	250 Knots or .70M
Extended (V_{LE}/M_{LE}):	300 Knots or .70M

Note: *The speed limit following use of Alternate Gear Extension is 300 Knots/.70M*

Flap Placard Speeds — (AFM)

V_{FE}:	Max	Min
0-13°:	280 Knots	See Quick-
14-20°:	240 Knots	Reference.
21-25°:	220 Knots	Cards in Cockpit
26-27°:	200 Knots (205, MD-83)	
28-40°:	195 Knots (200, MD-83)	
Limiting Mach Speed M_{FE}:	.57M	

Slats Extended Maximum Speed

Mid Position:	280 Knots/.57M
Full Extension:	240 Knots/.57M

Flap Settings Allowed for Normal Approach & Landing:

Flap Setting	Slats
0	Retracted
0	Extended
11	Extended
15	Extended
23	Extended
28	Extended
40	Extended

Use of intermediate flap positions, other than 23, (i.e., 18, 24, etc.) is prohibited.

OM Vol. 1, APP-LDG-G/A, p. 10.2

Turbulence Penetration Airspeed: The recommended turbulence penetration airspeed is 275 to 285 KIAS or Mach .75 to .79 (whichever is lower). At 10,000 feet and below, minimum recommended speed is 250 KIAS or minimum maneuvering speed (whichever is greater.) Do not fly less than minimum maneuvering speed for existing configuration.

Weight

Maximum Weights	DC-9-82	DC-9-83
Maximum Ramp Weight-(AFM):	150,500 lbs.	161,000 lbs.
Maximum Takeoff Weight-(AFM):	149,500 lbs.	160,000 lbs.
Maximum Landing Weight-(AFM):	130,000 lbs.	130,000 lbs.
Overweight Landings-(AFM):	Landing at any weight that above Maximum Landing Weight is an overweight landing. Refer to FM Part 1, p. 19.1-7 for overweight landing policy, and to QRH - MISC Overweight Landing, p. MISC-0.27	
Maximum Zero Fuel Weight-(AFM):	122,000 lbs.	122,000 lbs.

Air

Air Conditioning Automatic Shutoff Inoperative Dispatch Requirements:	If inoperative, both packs must be off for takeoff.
Cabin Differential Pressure Maximum:	8.07 psi
Maximum, TWA:	7.77 psi
Maximum Emergency Pressure Relief:	8.32 psi
Takeoff & Landing in Manual Control:	Takeoff must be made with Cabin Unpressurized
Unpressurized Flight—Max Altitude following In-Flight Depressurization:	14,000 Feet MSL
Exception—May be exceeded:	When terrain clearance requirements dictate
Maximum Altitude when A/C Dispatched for Unpressurized Flight:	10,000 Feet Pressure Altitude

APU

APU Air Switch:	Off for all in-flight operations.
Engine Starts with APU Supplying Air — First Engine:	Air Conditioning Supply Switches OFF
Second Engine:	Air Conditioning supply switch for the operating engine may be on if its pneumatic crossfeed valve is closed.
Operational Altitude — Maximum:	Same operational envelope as airplane.
Maximum, TWA:	FL 350

Starter Motor Duty Cycle:	**First Attempt:**	Must be followed by 5 minutes off
	Second Attempt:	Must be followed by 5 minutes off
Third Attempt:		Must be followed by 1 hour (60 minutes) off
		Note: *Starter duty cycle begins with first indication of RPM.*

			TWA Airplanes
EGT (AFM)	**Starting:**	100%	760°C for 30 Seconds
	Max Continuous:	100%	630°C
	Transient:	106%	663°C
Rotor Speed (AFM)	**Maximum:**	108%	110%

Auto Flight

Auto Throttle Use, with Engine Stall or Surge on Takeoff: (AD AD 92-10-163 R1) — Must be disconnected

Autopilot Use, General (AFM)

Cockpit Manning Requirements (AFM): Captain or F/O must be in seat with seat belt on to regain control should autopilot malfunction.

Coupled Approach with Out-of-Trim Light On (AFM): No auto coupled approaches if A/P out-of-trim light on more than 3 seconds after the aircraft is stabilized and tracking the glide slope.

Minimum Altitudes for Autopilot Use	Minimum Altitude
Enroute, including Climb & Descent, Excluding Approaches:	500' AFL
Approaches Autolandings:	NONE
ILS Coupled Approaches (Other than Autolandings) IFR:	70 Feet AFL
VFR:	50 Feet AFL
NON ILS / RNAV:	50 Feet below MDA

No Automatic Landing Allowed if (AFM) (FLEARRLES):
- ◆*Flight Controls—Any unusual control position or other abnormal conditions exist in the manual flight control system.*
- ◆*Either Inertial Reference Unit (IRU) is in Attitude or OFF mode.*
- ◆*Align (ALN) Mode is not annunciated on an FMA by 100 feet radio altitude.*
- ◆RUDDER CONTROL MANUAL *Light is ON.*
- ◆*Runway width is less than 145 feet (45 meters).*
- ◆*Landing overweight*
- ◆*Engines—Either Engine becomes inoperative at an altitude greater than 50 feet above the runway.*
- ◆*Spoilers—Automatic Ground Spoilers are not armed and operational.*

Automatic Landings—May be Made under These Conditions

Airplane(LAT):
- ◆LMP STATUS *Placard Holder—EMPTY* **OR** *If the MEL 22-90 pocket (right side) is placarded requiring a flight confidence check (FCC)*
- ◆*Auto-Flight System Operational Requirements for use of AUTOLAND are satisfied. Refer to SYSTEMS, Autoflight, Autopilot Operational Requirements, p. 25.24 - 25.25*
- ◆*Tested—An Autoflight Pre-Flight Test must be accomplished on any DFGC to be used for an automatic landing on that flight.*
  (AFM; See SYSTEMS, p. 25.1 for test; 25.24-25 for requirements.)

Runway:
Do not autoland on a runway that the localizer is unusable inside the runway threshold or localizer is unusable for rollout guidance.
Authorization— CAT I, CAT II or CAT III runway
(OM Part I p. 10-27 & OM Vol. 1 App-Landing-Go Around 40.2)
♦TCH—Glide slope TCH must be 35' or greater.
OM Vol. 1 Approach-Landing-Go Around 40.2)

Wind(25-15-10-10):
- ♦♦**25** *Knots—Maximum Headwind*
- ♦**15** *Knots—Maximum Crosswind (may be further reduced by FM Part I, crosswind limitations, and by visibility.)*
- ♦**10** *Knots—Maximum Tailwind* *page 6 of this Study Guide*
- ♦**10** *Knots—Maximum gust factor, or steady state wind additive over 5 knots.*
  (OM Volume 1, Climb-Cruise-Descent p. 10.3)

Communications

Boom Microphones:

Required use: If operative, use is required below 18,000' MSL on aircraft having a placard stating this requirement on the Captain's and F/O's instrument panels.

MEL Requirements: MEL 23-12—Boom Microphones; applies if either boom microphone is inoperative.

Electrical

Generator Load		
Engine Generators	**Normal:**	Less than 1.0
	Normal Maximum:	1.5 for 5 Minutes
	Peak:	Over 1.5 for 5 seconds.
APU Generator	**Max on Ground:**	1.25
	Maximum below FL 250:	1.0
	Maximum FL 250-300:	0.7
	Maximum above FL 300:	0.625
Generator Limits	**Voltage:**	115V ± 8V
	Frequency:	400 Hz ± 20 Hz

Battery Limits	**Fully Charged, Expected Time:**	Fully charged batteries will supply Emergency Power for ≈ 30 minutes
	Normal Voltage:	25-33 V
Minimum Voltage EMER PWR	**Power Selector ON (Battery under load):**	25V
	Amps Charging:	0-40 Left
	Amps—Emergency Power Selector ON:	10-50 Right
DC Bus Limits	**Voltage:**	22-30V
	Load:	1.0
	Normal Max Difference Between Indicators:	≤ 0.3
	Normal Expected Load Indication:	≥ 0 (Should indicate some load)

Engines, APU

RPM

RPM (AFM)		N_1	N_2
	Reserve Thrust:	Red Radial Line (101.6%)	Red Radial Line (102.5%)
	Max Thrust:	219—Orange Radial Line (98.8%)	Orange Radial Line (100.9%)

EGT	Operating Condition		Temperature	Time
	Starting (AFM):	**Ground:**	500°C	Momentary(See Note 1)
		Flight:	625°C	Momentary
	Takeoff (AFM):	**Reserve Thrust:**	625°C	5 Minutes (See Note 2)
			Red Radial Line (630°C)	2 Minutes
		Max Thrust:	590°C	5 Minutes (See Note 2)
			Orange Radial Line (595°C)	2 Minutes
	Max Continuous (AFM) / Climb:		Below Amber Arc (580°C)	Continuous
	Max Cruise:		540°C	Continuous

Engine EGT Notes:
1. If 500°C EGT limit is exceeded (any duration), immediately shut down engine. Record peak EGT & duration of overtemp in AML. Maintenance action req'd.
2. Use of takeoff thrust (Max and / or Reserve) must not exceed 5 minutes.
   If any EGT limit (takeoff / in flight) is exceeded, refer to QRH - EMER / ENG / EGT Inoperative or Reads High

Automatic Reserve Thrust (ART) System **(AFM):** The ART system must be OFF when using the T. O. FLX mode (Standard Thrust) of the thrust rating system.

Oil

Pressure		MD82 / 83	TWA
	Normal Pressure:	Green arc	SDP 40-55
	Low Pressure:	Amber arc*	SDP 35-40 psi*
Perform Low Pressure Abnormal	**Procedure:**	Below Red Radial Line	SDP < 35 psi**

*Tolerable only for remainder of flight, preferably at reduced power setting
**Refer to QRH – Engines

Note: *Cold weather starts may result in oil pressures outside the green arc(TWA SDP outside green arc—40-55 psi). Engine may not be run above idle until pressure returns to green arc.*

Temperature		MD82 / 83	TWA
	Max Continuous:	Less than Amber Arc	SDP 135°C
	Max for 15 Minutes:	Amber Arc	SDP 135-165°C

Quantity	**Required for Dispatch:**	12 Quarts—Flight Duration 4 Hours or Greater 4 Quarts + 2 Qts / Hour per Engine for planned Flight Duration < 4 Hours
Consumption	**Allowable Rate:**	1 Quart per hour per engine maximum, or E-6 write-up is required. *See LIM 10.17 if exceeded for details.*

Approach Idle **Operations with System Failed to High, One or Both Engines (AFM):** ART must be activated (solenoids actuated) prior to taxi for T/O, and prior to taxi after landing.

Thrust Reversers	**Powerback operations:**	Not Authorized
	In Flight Use:	Do not operate in flight

Power back operational limits remain in the OM. Details have been removed from this Study Guide to eliminate confusion and for space considerations.

Engine Starter Duty Cycle	**1st Start Attempt:**	90 Seconds ON, 5 Minutes OFF May Consist of one 90 Second Motoring Cycle or three normal 30-second start cycles in succession. Check that N_2 has decreased to zero between each start attempt.
	Subsequent Attempts:	30 Seconds ON, 5 Minutes OFF
Engine Ignition Duty Cycle	**CONTIN:**	Continuous
	OVRD, GND & FLT START:	2 minutes ON, 3 minutes OFF *then* 2 min. ON, 23 min. OFF
	OVRD/START Extended Duty Cycle:	20 Minutes ON, 10 Minutes OFF (E-6 Write-up Required)
	In Flight CONTIN Inop, OVRD System Used:	OVRD may be operated to extended duty cycle of 20 min. on, 10 min off. AML entry is required when this extended duty cycle is used.
TWA (Most A/C)	**A/B Ignition Duty Cycle:**	Operation of ignition in A, B, BOTH or OVRD is limited to 10 minutes ON, followed by 10 minutes OFF
TWA	**For Continuous Ignition:**	Alternate between A and B positions
Engine Synchronization	**(AFM):Use Below 1500' AGL:**	Must be OFF
Takeoff Thrust	**ART Inop, Performance Manual Does NOT Authorize STD Thrust:**	Use Reserve (RSV) Thrust
	ART Inop, Performance Manual Authorizes STD Thrust:	Use Standard (STD) Thrust
	ART Operative, Performance Manual Does NOT Authorize STD Thrust:	ART System Armed (ART Switch AUTO, green READY light ON), use MAX Thrust

Flight Controls

Flaps — **Prohibited Range:** Do not use flap setting ***between*** 13° and 15°.
13° & 15° ***Are*** authorized settings.

Ground Spoilers — **Arming-In Flight (AFM):** Do not arm prior to gear extension.

Mach Trim Compensater (AFM)
System Inop or Malfunctions In Flight: Switch to OVRD to remove any trim it may be supplying.
Max Speed with Malfunction: M_{MO}, = .78M

Rudder Power — **Requirements for Takeoff:** Must be ON for takeoff

RUDDER CONTROL MANUAL
Light On In Flight (AFM): Do not reduce below approach speed OR 135 Knots (whichever is higher) until landing is assured.

RUDDER TRAVEL UNRESTRICTED
Light On In Flight (AFM): If the light stays on >180 KIAS (MD-82) or 200 KIAS (MD-83), then for all operations above these speeds:
- ◆Rt. Eng Hyd Pump must be **LOW**, and Aux and Power Transfer Pumps **OFF** ***OR***
- ◆Rudder Hydraulic Control Lever must be in the **MAN** position.

Slats — **AUTO SLAT FAIL Light ON (AFM)**
Max Speed with Flap/Slat Handle out of Up/Ret: 240 KIAS
Prior to Slat Extension: Reduce speed to below 240 KIAS
Slat Position for Takeoff: Slats must <*verified to*> be at mid position (Flaps 0-13°) or fully extended (Flaps 15-24°) <*prior to*> takeoff.
<u>**Editor's Note**</u>: *<Bracketed wording modified from OM for clarity.>*

Speed Brakes
Use in Combination with Flaps & Slats: Allowed only with Flaps/Slats **UP/RET *or* 0/EXT** configuration
Use in Combination with Landing Gear: Do not extend or retract gear with speed brakes deployed.
Ground Spoiler Use (Lever beyond EXT): May not be used in flight (ground use only in this range.)

Flight Instruments

Electronic Flight Instrument System (AFM)
MAINT CHECK Annunciator Illuminated: Do not take off with light illuminated.
EFIS Symbol Generator Switch: Must be in NORM position except for in-flight failures of an EFIS symbol generator.
GFMS Primary Navigation,Approved Display Modes: Data displayed on EFIS in MAP, or NAV in ROSE, ARC or COMPACT
FD Requirements if MAP Displayed: For takeoff and landing, FD must be operative on PFD of each pilot who has MAP mode selected on the ND
Use of Compact Mode: See LIM-10.21

FMS

Conditions of Approval— Program: Single GFMS system approval for terminal & enroute navigation with program HT9100-005F (or later) installed.

Primary means of Navigation — for Routes: In North America below 70° N Latitude and the Caribbean.
<u>**With Single FMS**</u>: **Approved for Nav:** Approved for terminal and enroute navigation for operations in N. America ***below 70° N*** latitude and the Caribbean.

<u>**Limitations**</u> — **When UNABLE RNP is displayed:**
- ◆En Route and terminal IFR operations can be continued providing the system position is ***verified every 15 minutes***, using other approved navigation equipment.
- ◆Must report degraded navigation performance to ATC.

Use of Dead Reckoning Mode:
- ◆Navigation cannot be predicated on this mode ***but***
- ◆May be used when no other means available

<u>**Currency Verification**</u> — **Preflight:** Pilot must verify currency of program before using
Out-of-Date Program Use: IFR Navigation prohibited unless each selected waypoint and NAVAID is verified for accuracy using current chart data.

<u>**Holding**</u>— **Holding Patterns:** ◆GFMS Use authorized
Approaches: ◆GFMS Use on the final approach segment is authorized.

TWA <u>**Flight Management System**</u> **(FMS) (96xx)**
DFGC Version for FMS: -970 or Subsequent
Use for Range, Fuel Management and Engine Out Terrain Clearance: Not Authorized. Performance predictions not demonstrated.
Authorized for use with at least two DMEs:: VFR/IFR RNAV operation in accordance with OCEANIC REMOTE, ENROUTE, TERMINAL and NON-PRECISION APPROACH criteria of AC20-130A
Terminal Area and Approach Operation: Must have one EFIS NAV display in ARC or ROSE mode to crosscheck FMS position with navigation radio data.
Operations requiring RNP Alert Condition: Must verify position using other available navigation systems
FMS Not Authorized Regions: N of 80° North, S of 60° South

Raw Data Monitoring Requirements
While maneuvering for approach: One EFIS NAV display must be in the ARC or ROSE mode until established on final approach course to crosscheck FMS position.
<u>**Note**</u>: *When appropriate, compare aircraft position on the map with ILS, VOR, DME, and ADF systems to detect possible map shift errors.*



Vertical and Lateral Navigation	
Minimum Altitude for VNAV Engagement:	1,000' AGL
Minimum Altitude for NAV Engagement:	400' AGL
FMS-VFR Approach:	Authorized in VMC only; may be used as monitor only in IMC
VNAV and NAV use below MDA or DH:	FNAV & NAV must be manually disengaged below MDA or DH
VNAV Use with Autothrottles:	May only be used with both engines operating

Fuel (AFM)

Fuel Management and Loading (AFM)	
Boost Pumps—T/O & Landing:	Two pumps in each tank must be operating. **Exception:** *See MEL*
Aux Tank Pumps—T/O & Landing:	All Aux Tank fuel pumps must be OFF.
Max Fuel Usage, Center Tank, Prior to Aux Tank Fuel Transfer to Center Tank:	No more than 8500 Pounds may be used from center tank prior to transferring all Aux Tank Fuel into the center tank.
Tank Feed Order After Takeoff:	Must use center & aux tanks (if installed) before main tank fuel
Fuel Pump Switch Action when Tank Empties:	Shall be shut off without delay
When Tanks Empty, Related pumps must be:	Shut off without delay
Fuel Density Range:	6.3-7.1 Pounds per Gallon
Max Imbalance, Main Tanks:	1500 lbs.
Aux Tanks:	400 lbs.
Ballast Fuel Limitations:	See Operating Manual, Vol. 1, LIMITATIONS 10.24
Fuel Distribution Exceptions:	For fuel loads where center and aux tank fuel is carried but wing tanks not full, see restrictions: OM Vol. 1, p. LIMITATIONS 10.25
Fuel Specifications Standard Fuels:	Jet A, Jet A-1, JP-5, JP-8
Alternate Fuels:	JP-8 + 100 (Must coordinate with MOC prior to fueling.) Jet A50
Prohibited Fuels:	JP-4, Jet B, Aviation Gasoline (AvGas.) Use of any other fuel except listed above is not authorized unless approved in advance by MOC.
Inadvertent Mixture of Aviation Gasoline (Av Gas)	In the event of inadvertent mixing of aviation gasoline with kerosene during fueling, the associated fuel tank(s) must be defueled.
Center Tank Pump Check (AFM) AD 1989-07-17 — Requirements:	Prior to ***engine start*** on flights where ***center tank fuel is present and will be needed for that route segment***, center tank fuel pumps must be individually checked to verify pump operation. Accomplished by observing both **INLET FUEL LOW PRESSURE** lights out when each individual **CTR** tank pump is activated.
Fuel Pump Circuit Breaker Reset (AFM) AD 2008-11-15 — Inflight:	Prohibited
Ground:	Not permitted until it has been determined by maintenance it is safe to do so

Hydraulics

Hydraulic Pumps Required Operating for All T/Os and Landings: Power Transfer Unit:	ON
Left Engine Hydraulic Pump:	HIGH
Right Engine Hydraulic Pump:	HIGH
Right Auxiliary Hydraulic Pump:	ON
Aux Hydraulic Pump Circuit Breaker Reset (AFM) AD 2008-11-15 — Inflight:	Prohibited
Ground:	Not permitted until it has been determined by maintenance it is safe to do so
Hydraulic Pressure Engine Pumps High:	2800 to 3100 psi acceptable range
Electric and Engine Pump Maximum:	3200 psi
Engine Pumps Low:	1300 to 1600 psi acceptable range
Engine Pump Low Maximum Pressure:	1700 psi OM Volume 1, SYSTEMS 70.2

Ice & Rain

Ice Requirements: Upper Wing Surface:	***None Allowed*** for takeoff
Lower Wing Surface:	1/8" ***Frost*** max allowed—underwing fuel tank surfaces only.
Upper Wing Inspection Pilot Must verify:	Heater area of the wing is free of ice contamination prior to engine start for takeoff. Verification may be accomplished by assuring over wing heater system **WARM** light is **ON**. **Caution**: *During inspection, include wing surface beyond heater panel, as clear ice may form in these areas.*
Over wing Heater System(AFM) Inspections Requirements — WARM Light ON:	No further action needed
WARM Light Not ON:	Reset by pressing light assembly If **WARM** light comes back on—no upper wing check required If **WARM** light does NOT come back on— Physical (hands on) check of upper wing surface, as described in QRH - ANTI-ICE, RAIN - **Overwing Heater FAIL**, required if either of the following conditions exist: • Ambient temperature is less than 10°C (50°F) and high humidity or visible moisture (rain, drizzle, sleet, snow, fog, etc.) is present. • Frost or ice is present on the lower surface of either main wing fuel tank.

Physical (Hands On)	**Note**: *See OM Vol. 1 LIM 10.28 and Q*
Upper Wing Surface Check Required:	♦System disarmed ***or*** ♦WARM Light ***not ON or*** ♦Either system **FAIL** light **ON** ***AND*** ♦Temp. less than 10°C(50°F) ***or*** ♦Frost or ice present on either wing main tank lower surface See additional notes, OM Volume 1, LIMITATIONS – 10.28
Icing Conditions Definitions **Ground Operations and Takeoff:**	RAT 6°C (42°F) or below **AND** Visible moisture present such as clouds, fog with visibility one mile or less, rain, snow, sleet, or ice crystals. ***OR*** When RAT is 6°C (42°F) or below and the temperature-dew point spread is 3°C (5°F) or less Icing conditions also exist on the ground and for takeoff when the RAT is 6°C (42°F) or below when any form of moisture is present (standing water, snow, slush etc.) which may be ingested into engine inlets, nacelles or sensor probes. **Note**: *One engine taxi authorized if no significant precipitation is occurring (snow, sleet, freezing rain) that could adhere to or collect in engine inlet.*
In-Flight:	RAT 6°C (42°F) or below **AND** Visible moisture in any form is present (such as clouds , rain, snow, sleet, or ice crystals.)
Engine Anti-Ice Required ON: **For Ground, Takeoff and Flight Operations:**	When icing conditions exist or are anticipated (as defined above.)
Airfoil Anti-Ice **In-flight Use:**	When icing conditions exist or are anticipated.
Takeoff Use:	Not used for takeoff or until above 1000' AFL (Airport Analysis based on no use until 1000' AFL.)
Minimum Duct Pressure:	20 psi with airfoil anti-ice on
Minimum Thrust in Icing Conditions:	Sufficient to keep L/R ICE PROTECT TEMP LOW light out
Application of Tail De-Ice is Required:	♦Once every 20 minutes ♦One minute prior to extension of landing flaps ♦After leaving icing conditions, before turning system off
TWA **Note, Single Airfoil Anti Ice:**	With single Airfoil Anti-Ice Switch, the tail is de-iced automatically for 2½ minutes every 15 minutes and when the system is turned off.
Standing Water and/or Slush (AFM):	♦Engine Ignition must be in CONTIN (TWA A or B) for T/O & landing ♦Static port heaters—ON if temperature ≤ 5°C/40°F
Windshield Heat Requirements (AFM) **General:**	On and checked for all flight operations
Center, CA, or F/O's Windshield Heat Inop, Max Speed:	315 KIAS under 10,000 feet Pressure Altitude.
Center, CA, or F/O's Outer Glass Ply Cracked:	315 KIAS maximum under 10,000 feet Pressure Altitude. Windshield heat for affected window OFF.
Center, CA, or F/O's Inner Glass Ply Cracked:	235 KIAS maximum under 10,000 feet Pressure Altitude. Windshield heat for affected window OFF. Note: *No speed restriction above 10,000 feet and no speed restrictions associated with clear view or eyebrow windows.*

Landing Gear

Anti Skid **Requirement for ALL Ops (AFM):**	Must be Operative
Auto Brakes **With Hydraulic System Failures:**	Do not use Auto-brakes if either hydraulic system fails
Brake Temperature **Maximum for T/O:**	205°C — Do not take off if any brake temperature exceeds.
Maximum Temperature to set Parking Brake:	300°C
Brake Wear Limits:	With Parking Brakes parked, indicators must extend beyond the brake housing as follows:
MD-82:	Flush or greater
MD-83:	½ Inch above flush or greater
Maximum Tire Speed:	195 Knots
Brake Pressure Bleed Down:	See Flight Manual, LIMITATIONS, p. 10.31

Miscellaneous

Evacuation Systems **Slide Arming Required:**	Any time airplane is in motion
With Passengers on Board:	At least one slide must be armed
Aft Bulkhead Door Emergency Operating Handle:	Must be exposed with normal handle covered from time airplane moves from gate until it stops moving on arrival
Emergency Lights **Must be armed:**	For all flight operations
Oxygen Pressure **Minimum at 70°F Bottle Temp.:**	1100 psi. See OM Vol. 1, LIM 10.32 for other temperatures
Flight Deck Door and Flight Access System **Preflight:**	Required once each flight day
Access Code Procedures:	See OM Vol. 1, LIM 10.32 for other temperatures
Locking with L DC Bus Unpowered:	Use Deadbolt
Use of Deadbolt Position with Key:	Ground Only

Navigation

Navigation Instrument Tolerances	
CA's ND Course Pointer vs. FO's #1 VOR RMI Pointer:	5°
FO's ND Course Pointer vs. CA's #2 VOR RMI Pointer:	5°
#1 ADF/VOR Pointer vs. #2 ADF/VOR Pointer tuned to same station:	8°
CA's ND Compass Card vs. FO's Compass Card:	5°
TWA **Slewing Compass After Inflight Alignment:**	Controllers should not be slewed (may result in attitude errors)
96xx Airplanes, Alignment Movement:	Aircraft must be stationary (Normal motion due to passenger and baggage loading is within tolerances
Temperature Difference Between Units:	11° (if more than this, **IRS ALIGN HOLD** light
Temperature Minimum:	-20° (if below this, **TEMP LOW** light)
Latitudes for for 2.5-10 minute alignment:	Between 70° N and 60° S
Maximum northern latitude for 15 minute alignment:	78.25° N
Minimum Equipment Required:	One Multifunction Control and display unit (MCDU)

Warning & Alert

Traffic Alert and Collision Avoidance System **(TCAS)**	
Authorized Deviation:	To the extent necessary to comply with a TCAS II RA
Initiating Evasive Maneuvers for TA's Based Only on Information Shown on the TCAS Traffic Display:	Prohibited. These displays and advisories are intended for assistance in visually locating the traffic and lack the resolution necessary for evasive maneuvers.
Compliance with an RA:	Required, unless in the opinion of the Captain, doing so would compromise the safe operation of the flight. (Applies even if visual)
Maneuvers in Response to an RA which are in the Opposite Direction of that Advisory:	Prohibited, unless they are the only means to assure safe separation.
Other critical Warnings such as Stall, Windshear or GPWS:	Take precedence over an RA.
Manner of Response:	Manually and smoothly (A/P and A/T off)
Impact of Transponder altitude reporting OFF:	TCAS is disabled
Other Critical Warnings' Precedence:	Warnings such as stall & GPWS take precedence over RA response
Weather Radar**—Do Not Operate Hangar:**	Within a hangar
Fueling:	Within 50' of fueling operations or fuel spills
Personnel:	Within 160'
Warm Up:	In Standby Position Only (If applicable)
Enhanced GPWS **(AFM) Standby Altimeter:**	Must be set to QNH
Authorized Deviation:	To the extent necessary to comply with an EGPWS warning
Navigation Based on use of Terrain Display:	Prohibited
Lighting Requirements for use at Night:	Instrument panel flood lights must be operative
Use at airport not contained in EGPWS Database:	Must be inhibited within 15 minutes of takeoff, approach or landing **Note**: *All authorized AA airports (regular, provisional, refueling, alternate and designated emergency airports) are contained in the database.*
TWA **Use with FMS White or Amber** RNP **message in upper left corner of EFIS PFD:**	Must be inhibited
Position Updating Requirement:	EGPWS must be inhibited (Terrain **OVRD** Switch to **OVRD**), unless ◆FMS position is updated at the end of the runway, ***or*** ◆Verified with actual runway position, ***by*** ◆◆Ensuring that with the Mode Select Panel Range selected to 10NM, A/C symbol is on the runway symbol at the appropriate end of the runway, ***or*** ◆◆The "Internal GPS card not navigating" message is present.
Overspeed Warning **Inoperative, Maximum Speeds— V_{MO}:**	325 Knots below 25,300 Feet
M_{MO}:	.79 Mach above 25,300 Feet See additional notes Limitations 10.36 **Caution**: *If overspeed warning system is deactivated, carefully monitor Mach/Airspeed Indicator(s). When the black* **CAWS FAIL ANN** *circuit breaker is pulled, aural warnings are also inoperative for* ***engine fire*** *and* ***horizontal stabilizer position***.
Windshear Alerting & Guidance System **(WAGS) (AFM)**	
AD 1992-03-06 Bank-Related Desensitization:	During sustained banks of greater than 15°, WAGS is desensitized and alerts resulting from encountering windshear conditions will be delayed.
During Single Engine Operation:	WAGS Capability has not been demonstrated for SE operations.

Emergencies

Memory Items

Procedural changes have been made such that there are now only three memory items:

Complete Loss of AC Power (QRH Electrical 6.1)

Condition: Loss of normal AC and DC power has occurred

1 EMER PWR SWITCH....................ON

Reverser Deployed or ENG REVERSE THRUST and/or UNLOCK Illuminated Inflight (QRH Engines 7.3)

Condition: Reverser is deployed or unlatched inflight.

1 Autopilot/Autothrottle....................OFF
2 Throttle (affected engine)....................(Confirm) IDLE

Runaway Stabilizer (QRH Flight Controls 9.1)

Condition: Uncommanded stabilizer trim movement occurs continuously.

Note: Extended trim operation may result in trim motor thermal shutdown. Trim motor operation may return after sufficient cooling period.

1. Autopilot (If engaged)....................Disconnect
2. **If** runaway movement continues:
   Control wheel trim switches....................Trim opposite direction of runaway as necessary

Former Memory Items

Note: *Procedures below this point on this page were formerly memorized due to the time-critical nature of the tasks involved. A policy change now involves reading and doing these items from a Quick Reference Card (QRC) stored in the cockpit. The procedures remain here for reference, but will be removed in a future revision if no further policy changes occur.*

Airspeed Unreliable (QRH Flight Instruments, Displays 10.1)

Condition: Possible malfunction of pitot static system, air data computer, or instruments.

1 Autopilot/Autothrottle/Flight Directors....................OFF
2 Airplane pitch/thrust:
   If flaps &/or slats EXT....................10° & 80% N1
   If flaps and slats UP....................4° & 80% N1
3 METER SEL & HEAT switch....................Verify not OFF

CABIN ALT / Rapid Depressurization (QRH Air Systems 2.1)

Condition: One or more of these occur:
- Cabin altitude exceedance.
- In flight, a modulating cabin altitude warning horn sounds, followed by the words, "*CABIN ALITITUDE*" and **CABIN ALT** light illuminates.

Oxygen masks....................ON / 100%
2 Communications....................Establish
3 CABIN ALT control lever/wheel....................MANUAL/FULL FORWARD

Note: Manual control wheel forces may be high. Apply force as required.

4 PNEU X-FEED VALVE levers....................Close
5 AIR CONDITIONING SUPPLY switches....................AUTO
6 Passenger Oxygen Masks (if required)....................Deploy

If cabin altitude has exceeded 14,000 feet and passenger oxygen masks have not deployed, move PAX OXY MASK switch to EJECT.

Cockpit Smoke Removal — Unpressurized (QRH Fire Protection 8.17)

Condition: Smoke is present in the cockpit.

1. Oxygen masks and goggles....................ON / 100% / EMERGENCY
2. Communications....................Establish

Engine Fire / Damage / Separation (QRH Fire Protection 8.18)

Condition: One or more of these occur:
- Engine fire warning
- Airframe vibrations with abnormal engine indications

At or Above Engine Out Acceleration Altitude:

1. Autothrottle (if engaged)....................OFF
2. Throttle (affected engine)....................(Confirm) IDLE

TAIL COMPT TEMP HIGH (QRH Air Systems 2.3)

Condition: Tail compartment temperature is high.

1. PNEU X-FEED VALVE Levers....................CLOSED
2. AIR FOIL anti-ice switches....................OFF
3. AIR CONDITIONING SUPPLY switches....................HP BLD OFF

Two Engine Flameout (QRH Engines 7.5)

Condition: Both engines have loss of thrust.

1. EMER PWR switch....................ON
2. ENG IGN selector....................OVRD

Maneuvers

Note: Only selected maneuvers are reproduced here for study. Notes are abbreviated for brevity and ease of study. Refer to QRH, MANEUVERS section for other procedures and full text of notes. Procedures are taken from the QRH, which states, **"This section is a consolidation of emergency maneuvers. Pilots are expected to be proficient in the performance of these maneuvers."**

Approach to Stall or Stall Recovery

WARNING

During takeoff, a stick shaker, STALL warning light, horn, or "STALL" aural warning at rotation may indicate an improper flap/slat configuration. PF immediately calls out, "SLATS EXTEND" and PM confirms, "SLATS EXTENDED."

If control column does not immediately provide the needed pitch response, full forward control input may be necessary. Excessive use of pitch trim may aggravate the condition, or may result in loss of control, or high structural loads.

CAUTION

Do not ignore short duration warnings. Take immediate action.

Note

Do not use flight director commands during the recovery.

Premature recovery may result in a secondary stall or inability to accelerate with thrust available.

All recoveries from approach to stall should be done as if an actual stall has occurred. If conditions permit, accept an altitude loss while accelerating to minimum maneuvering speed for existing configuration.

(OM Vol. 1, MANEUVERS 10.1.1, 10.1.2):

Pilot Flying	Pilot Monitoring
First indication of stall (buffet or stick shaker)	
Initiate the recovery: — Hold control column firmly — Disconnect autopilot and autothrottle — Apply takeoff/go-around or MCT thrust as applicable. If ground contact is imminent, apply thrust to mechanical stops. — Smoothly apply nose down elevator to reduce the angle of attack until buffet or stick shaker stops	— Monitor altitude and airspeed — Verify all required actions have been accomplished Call out — Any omissions — Trend toward terrain contact
Continue the recovery: — Roll in the shortest direction to wings level, if needed — Confirm speed brakes stowed — Advance thrust levers as needed — If flaps/slats or landing gear are extended, do not change configuration during stall recovery	— Monitor altitude and airspeed — Verify all required actions have been accomplished Call out — Any omissions — Trend toward terrain contact
Complete the recovery: — Check airspeed and adjust thrust as needed — Establish pitch attitude — Return to the desired flight path — Re-engage the autopilot and autothrottle if desired	— Monitor altitude and airspeed — Verify all required actions have been accomplished Call out — Any omissions — Trend toward terrain contact

Ground Proximity Warning Actions & Callouts

Correct the flight path or aircraft configuration for the following:
— CAUTION OBSTACLE
— CAUTION TERRAIN
— DON'T SINK
— GLIDESLOPE
— TOO LOW FLAPS
— TOO LOW GEAR

"GLIDESLOPE" may be canceled or inhibited if:
— Conducting a localizer or back-course approach
— Circling approach for an ILS
— Conditions require a deliberate approach below glide slope
— Glide slope signal is unreliable

[1] If go-around thrust is exceeded at any point during the escape maneuver, make an AML entry.

Note

If a terrain caution occurs and positive visual verification is made that no obstacle or terrain hazard exists when flying under daylight VMC conditions, the alert may be regarded as cautionary and the approach may be continued.

Some aural warnings repeat.

(OM Vol. 1, MANEUVERS 10.2.6)

Pilot Flying	Pilot Monitoring
Ground proximity warning aural alert activated	
— Disconnect autopilot — Throttles - TOGA or full forward (if ground/obstacle contact is imminent)[1] — Simultaneously roll wings level and rotate to an initial pitch attitude of 20° — Retract speedbrakes — Trade airspeed for climb performance. If necessary (to prevent ground contact), continue to increase pitch attitude until stick shaker actuates.	— Verify power settings — Verify all required actions have been completed
"Set go-around thrust."	
— Do not change gear or flap configuration until terrain separation is assured — Monitor radio altimeter for sustained or increasing terrain separation — When clear of terrain, slowly decrease pitch attitude and accelerate	Call out: — Any omissions — Any trend toward terrain contact — Monitor vertical speed and altitude (radio altitude for terrain clearance and barometric altitude for a minimum safe altitude)

Moderate to Heavy Rain, Hail or Sleet

Flights should be conducted to avoid thunderstorm or hail activity. If visible moisture is present at high altitude, avoid flight over the storm cell. (Storm cells that do not produce visible moisture at high altitude may be overflown safely.) To the maximum extent possible, moderate to heavy rain, hail or sleet should also be avoided.

(OM Vol. 1, MANEUVERS 10.3)

If moderate to heavy rain, hail or sleet is encountered:
ENG IGN switch ......CONTIN or A or B
PNEU X-FEED VALVE levers ......Open
ENG / AIRFOIL ANTI-ICE switches ......As required

Note

Engine and airfoil anti-ice systems should be off if RAT is above 6°C and no icing is encountered or anticipated. Reduced engine bleeds will increase engine flameout margin during periods of heavy water ingestion.

Autothrottle ......OFF
Throttle... Adjust slowly

If thrust changes are necessary, move throttles slowly. Avoid changing throttle direction until engines have stabilized at a selected setting. Maintain an increased minimum thrust setting.

Airspeed.... Use a slower speed

Using a slower speed improves engine tolerance of heavy precipitation intake.

Consider starting APU.

Rejected Takeoff

CAUTION

Should directional control become a problem while in reverse thrust, reduce reverse thrust to reverse idle (or forward idle, if required), regain directional control and re-apply reverse thrust as necessary.

Note

If an engine remains at high forward thrust, shut it down using fuel lever.

Prior to 80 knots, the takeoff should be rejected for any of the following:
- Activation of the MASTER WARNING/MASTER CAUTION
- System failure(s)
- Unusual noise or vibration
- Tire failure
- Abnormally slow acceleration
- Unsafe takeoff configuration warning
- Fire or fire warning
- Engine fire/engine failure/compressor stall
- Windshear warning
- Aircraft is unsafe or unable to fly

Above 80 knots and prior to V1, the takeoff should be rejected for any of the following:
- Fire or fire warning
- Compressor stall
- Engine failure
- Windshear warning
- Engine fire
- Aircraft is unsafe or unable to fly

See additional notes in Maneuvers section.

(OM Vol. 1, MANEUVERS 10.4.1)

Captain	First Officer
The captain decides to reject the takeoff	
"Reject, my aircraft."	
	If aircraft control is transferred
	"Your aircraft."
Auto Spoilers - ARMED Without delay, rapidly and simultaneously: – Retard throttles to idle – Apply maximum manual braking – Initiate reverse thrust consistent with conditions – Verify spoilers extended. **If** spoilers fail to extend, extend manually Be alert for directional control problems from asymmetrical reverse thrust **Auto Spoilers - Not ARMED, or TWA aircraft** Without delay, rapidly and simultaneously: – Retard throttles to idle – Apply maximum manual braking – Extend spoilers – Initiate reverse thrust consistent with conditions Be alert for directional control problems from asymmetrical reverse thrust	Apply slight forward pressure on control column. Verify: – Throttles idle – If an engine remains at high forward thrust, immediately advise captain – Spoiler Lever full aft **"Deployed."** If spoilers do not deploy (or fail to remain deployed): **"No spoilers."** Captain will manually deploy spoilers. Reverse thrust applied. If an engine fails to reverse: **"No reverser left engine."** or **"No reverser right engine."** or **"No reversers."** Advise control tower as soon as practical, especially during low visibility conditions
At 100 knots	
	"100."
At 80 knots	
	"80."
At 60 knots	
	"60."
When the aircraft is stopped	
Consider accomplishing the following: – Advise F/As and passengers to remain seated or to evacuate – Request ARFF – Complete checklist (if appropriate) for conditions which caused the RTO – Clear the runway, if feasible – Call for Maintenance inspection	

Tailstrike

CAUTION

Do not pressurize the aircraft. Pressurizing the aircraft may cause further structural damage.

(OM Vol. 1, MANEUVERS 10.5)

Cabin Altitude Control Lever......MANUAL (Down)
Outflow VALVE ......Full aft

Plan to land at the nearest suitable airport. Conditions permitting, land at an company station where inspection / repair can be accomplished.

Engine Failure - Takeoff Actions & Callouts

[1] The FD TAK OFF mode will command the above schedule. If bank angles of more than 15° are used, accelerate to 0/RET MIN MAN speed.

[2] Recommended one engine climb speed is Slat Retract Speed +20 knots.

(OM Vol. 1, MANEUVERS 10.6.2)

1 ENGINE

Pilot Flying	Pilot Monitoring
Engine fails on takeoff	
"My aircraft."	
Maintain directional control	
At V_R	
	"Rotate."
Rotate to takeoff attitude	
After verifying positive rate of clime on VSI	
Verify positive rate of climb on the altimeter	Verify positive rate of climb on the altimeter
	"Positive Rate."
"Gear up." **"Runway heading, heading select"**	On command: — Position landing gear lever UP — Disarm spoilers
Use the following climb speeds to the TPS engine-out acceleration altitude[1] : — If an engine failure occurs after V1, but not above V2: • Maintain V2 — If an engine failure occurs after V2: • Maintain speed attained at time of failure not to exceed V2 + 10 — If an engine failure occurs at a speed greater than V2 + 10: • Reduce to and maintain V2 + 10	— Monitor engine and flight instruments — Monitor climb speeds
At engine out acceleration altitude or higher (if required)	
"Altitude Hold" **"Flaps Up."** and **"Slats Retract"** on schedule	— Monitor engine and flight instruments — Monitor climb speeds On command: — Select ALT HLD — Retract flaps / slats
At slats up + 20 knots[2]	
"IAS." **"A/C Override"** **"Set MCT"** Call for the appropriate checklist After aircraft is properly trimmed, the Autopilot may be engaged, if desired	On command: — Select IAS — Select AIR COND SHUTOFF switch - OVRD — Select MCT on TRI/TRP and adjust thrust on operating engine to EPR called for — Accomplish the appropriate checklist on command

Traffic Advisory (TA) Actions & Callouts

WARNING

Comply with the RA vertical guidance and ATC lateral guidance if there is a conflict between the RA and air traffic control.

Once an RA has been issued, safe separation could be compromised if current vertical speed is changed, except as necessary to comply with the RA.

(OM Vol. 1, MANEUVERS 10.7.1)

Pilot Flying	Pilot Monitoring
TCAS traffic advisory (TA) occurs	
Look for traffic using traffic display as a guide	
Call out any conflicting traffic	
If traffic is sighted, maneuver if needed	

Note

If stick shaker or initial buffet occurs during the maneuver, immediately accomplish the APPROACH TO STALL RECOVERY procedure.

If high speed buffet occurs during the maneuver, relax pitch force as necessary to reduce buffet, but continue the maneuver.

Do not use flight director commands until clear of conflict.

Resolution Advisory (RA) Actions & Callouts - Not in Landing Config

WARNING

A **DESCEND** (fly down) RA issued below 1000 feet AGL should not be followed.

(OM Vol. 1, MANEUVERS 10.7.3

Pilot Flying	Pilot Monitoring
TCAS resolution advisory (RA) occurs	
If maneuvering is required, disengage the autopilot and autothrottle — Smoothly adjust pitch and thrust to satisfy the RA command — Follow the planned lateral flight path unless visual contact with the conflicting traffic requires other action	
Look for traffic using traffic display as a guide. Attempt to establish visual contact.	
Call out any conflicting traffic	

Climb RA in Landing Configuration Actions & Callouts

Note

When responding to an RA, the aircraft should be maneuvered only as much as needed to satisfy the RA.

If an RA response requires deviation from an ATC clearance, expeditiously return to the current ATC clearance when the traffic conflict is resolved, the "CLEAR OF CONFLICT" message is heard, or follow any subsequent change to clearance as advised by ATC. In responding to an RA that directs a deviation from assigned altitude, communicate with ATC as soon as practicable after responding to the RA. When the RA is cleared, the flightcrew should advise ATC that they are returning to their previously assigned clearance or should acknowledge any amended clearance issued.

Other critical warnings such as windshear or GPWS take precedence over an RA.

(OM Vol. 1, MANEUVERS 10.7.4)

Captain	First Officer
TCAS resolution advisory (RA) occurs	
– Disengage the autopilot and autothrottles – Advance thrust levers forward to ensure maximum thrust is attained	
"FLAPS 15."	
– Smoothly adjust pitch to satisfy the RA command – Follow the planned lateral flight path unless visual contact with the conflicting traffic requires other action	– Verify maximum thrust set. – Position flap lever to 15 detent
	Verify a positive rate of climb on VSI **"Positive Rate"**
"Gear Up."	
	Gear Handle .... UP
Attempt to establish visual contact.	
Call out any conflicting traffic.	

Moderate Turbulence Actions & Callouts

(OM Vol. 1, MANEUVERS 10.8.1)

Pilot Flying	Pilot Monitoring
Moderate turbulence is encountered	
Airspeed: – Above 10,000 MSL - 290 KIAS or mach .78 whichever is lower – Below 10,000 MSL - 250 KIAS or Clean Minimum Maneuver may be used whichever is greater Altitude: – Fly the FMS optimum altitude when possible to enhance buffet margin and economy – Descend if necessary to improve buffet margin	– SEATBELTS selector - ON – Make PA - See FM Part I - Section 11 - Non-Routine PAs Typical Examples - Turbulence – ATC - Notify • Alert ATC of any significant altitude deviation (300 feet or greater)

Severe Turbulence Actions & Callouts

[1] For FMS aircraft: in areas of turbulence, fly the FMS optimum altitude when possible. Buffet margin and economy will be enhanced. Descend if necessary to improve buffet margin.

[2] Below 10,000 feet, the greater of 250 KIAS or minimum maneuver may be used. Do not fly less than minimum maneuvering speed for existing configuration.

(OM Vol. 1, MANEUVERS 10.8.2)

Pilot Flying	Pilot Monitoring
Severe Turbulence is encountered	
– Autothrottle - OFF – ENG / AIR FOIL anti-ice switches - As required – Autopilot - Monitor • Use the autopilot in turbulence • Closely monitor autopilot operation and be prepared to disconnect the autopilot only if the aircraft does not maintain an acceptable attitude • If the autopilot disconnects, smoothly take control and stabilize the pitch attitude – ENG SYNC selector - OFF – Throttle - Set1 – Speed - Turbulent Air Penetration • 275 to 285 KIAS or MACH .75 to .79 whichever is slower	– SEAT BELTS switch - ON – ENG IGN switch - CONTIN or A or B – Make PA - See FM Part I - Section 11 - Non-Routine PAs Typical Examples - Turbulence – ATC - Alert • Alert ATC of any significant altitude deviation (300 feet or greater)

Upset Recovery
Nose High Recovery Actions & Callouts

WARNING

Excessive use of pitch trim or rudder can aggravate an upset, result in loss of control, or result in high structural loads.

(OM Vol. 1, MANEUVERS 10.9.2)

Pilot Flying	Pilot Monitoring
Nose high upset	
Recognize and confirm the situation	
– Disconnect autopilot and autothrottle – Apply as much as full nose down elevator – Apply appropriate nose down stabilizer trim – Thrust, as appropriate – Roll (adjust bank angle to as much as 60 degrees) to obtain a nose down pitch rate Complete the recovery: – When approaching the horizon, roll to wings level – Check airspeed and adjust thrust – Establish pitch attitude	Call out: – Attitude, airspeed and altitude throughout the recovery – Any omissions
	Verify all required actions have been completed

Upset Recovery
Nose Low Recovery Actions & Callouts

WARNING

Excessive use of pitch trim or rudder can aggravate an upset, result in loss of control, or result in high structural loads.

(OM Vol. 1, MANEUVERS 10.9.2)

Pilot Flying	Pilot Monitoring
Nose low upset	
Recognize and confirm the situation	
— Disconnect autopilot and autothrottle — Roll in shortest direction to wings level (unload and roll if bank angle is more than 90°) Recover to level flight: — Apply nose up elevator — Apply nose up trim, if required — Adjust thrust and drag as required	Call out: — Attitude, airspeed and altitude throughout the recovery — Any omissions
	Verify all required actions have been completed

Windshear Escape Actions & Callouts

WARNING

If ground contact is imminent, apply throttles full forward as needed to recover.'

CAUTION

Airline policy for low level windshear advisories is that takeoff is permitted, however caution should be exercised. Flights may not takeoff or conduct the final approach segment to a runway when ATC has reported a runway specific "Microburst Alert."

Note

Windshear escape maneuver is required during takeoff or landing where there is risk of ground contact.

Avoid over-boosting the engines unless necessary to avoid ground contact. When encountering windshear "Escape, set go-around thrust."

[1] If go-around thrust is exceeded at any point during the escape maneuver, make an AML entry.

[2] Do not exceed the pitch limit indication.

(OM Vol. 1, MANEUVERS 10.9.2)

Pilot Flying	Pilot Monitoring
When encountering windshear	
"Escape, set go-around thrust"	
Simultaneously: — Disconnect autopilot — Throttles - TOGA If ground contact is imminent: — Disconnect Autothrottle — Advance throttles full forward1 — Roll wings level and rotate toward an initial pitch attitude of 15° — Follow flight director commands (if available)2 — Turn flight director switches OFF, if WAGS is inoperative	— Ensure go-around thrust is set — Ensure all required actions are completed Call out: — Any omissions — Altitude and trend information based on radio altimeter (e.g., "300 feet descending." or "400 feet climbing" Retract speedbrakes
Do not: — Change gear/flap configuration — Attempt to regain lost airspeed until windshear is no longer a factor	
After escape is successful	
— Resume normal flight — Retract gear and flaps as required	Issue PIREP to ATC

Windshear Alerts: During Takeoff

[1] Inhibited from 80 knots to 400 feet RA.
[2] Inhibited from 100 knots to 50 feet RA.
[3] Inhibited until rotation.

(OM Volume 1, MANEUVERS 10.10.4)

Alert	Prior to V1	At or Above V1
Caution[1] "Monitor radar display."	Delay/reject the takeoff	— Maneuver as required to avoid windshear — Consider using maximum thrust
Warning "Windshear ahead. Windshear ahead." [2] or "Windshear. Windshear. Windshear." [3]	Delay/reject the takeoff	Perform the Windshear Escape Maneuver
Unacceptable Flight Deviations	Reject the takeoff	— Perform the Windshear Escape Maneuver — At VR, rotate normally to 15° no later than 2000 feet runway remaining

Windshear Alerts: During Approach

1Inhibited below 400 feet RA.
2Inhibited below 50 feet RA.

(OM Volume 1, MANEUVERS 10.10.6)

Alert/Aural	During Approach
Caution [1] "Monitor radar display."	Continue the approach if able to avoid windshear Otherwise, execute a normal go-around and maneuver as required to avoid the windshear
Warning [2] "Go around. Windshear ahead."	Perform either: — A normal go-around or — The Windshear Escape Maneuver
Warning "Windshear. Windshear. Windshear."	Perform the Windshear Escape Maneuver
Unacceptable Airspeed Deviations	

Normal Procedures Notes

Notes for this section focus on numbers and key items which are frequently needed in the cockpit, (and possibly on orals and simulators!) and for which there is usually not time to refer to the book. An example is for engine hot start considerations. In some cases, the information has been assembled from various places in the OM. In these cases, reference page numbers have been provided. Other then this type of item, no attempt has been made to summarize the NORMALS section.

DFGC/Autoland Test

NO AUTOLAND light flashes 50 seconds, then off
Headings must be ±2° between CA & F/O indicators
OM Volume 1, SYSTEMS 25.1

Standardized Actions

Callouts—Bold Italics Actions-Non Bold PM Actions GreenGear

Takeoff	2 Engine Go-Around	Takeoff Engine Failure	1 Engine Go-Around
Autothrottle—ON ***Thrust Set***	***Go-Around*** ***Set Go-Around Thrust***	***Autothrottle—ON"*** ***Thrust Set***	***Go-Around*** ***Set Go-Around Thrust***
80 Knots—Check ***V_1*** ***Rotate*** ***V_2*** ***V_2+10*** ***Positive Rate,*** ***Gear Up***	***Flaps — 15*** (or ***Flaps 11*** as required) ***Positive Rate,*** ***Gear Up*** ***Set and Arm Missed Approach Altitude***	***80 Knots—Check*** ***V_1*** ***My Aircraft*** ***Rotate*** ***V_2*** ***Positive Rate,*** ***Gear Up*** ***Runway Heading, HDG SEL***	***Flaps 11*** **VREF + 5 Minimum** ***Positive Rate,*** ***Gear Up*** ***Runway HDG, HDG SEL*** ***Set and Arm Missed Approach Altitude***
Passing 400' AGL Minimum			
HDG SEL or ***NAV***	***HDG HOLD,*** ***NAV*** or ***HDG SEL*** ***Set Speed 200***		
Passing 500' AGL Minimum			
Autopilot ON (if desired)			***Set Speed 250***
> 1000 AFL		**EOAA**	**> 1000 AFL**
Half Rate ***Climb Power*** ***Flaps Up*** (on schedule)	***Half Rate*** ***Climb Power*** ***Flaps Up*** (on schedule) ***Speed Select***	***Altitude Hold*** ***If Engine Fire or Severe Damage:*** Memory Items Autothrottle...OFF Throttle Affected Engine..Confirm ....IDLE ***Flaps Up*** ***Slats Retract*** (On Schedule)	***Altitude Hold*** ***Flaps Up*** (On Schedule)
0/EXT			**0/EXT**
Slats Retract			***Slats Retract***
		0/EXT+ 20	
Clean Min Maneuver **IAS, Bank 30** **2500' AFL** ***IAS 250*** or ***SPD SEL 250*** or ***PERF*** or ***VNAV***		***IAS*** ***A/C Override*** ***SET MCT*** ***Checklist***	***IAS*** ***A/C Override*** ***SET MCT*** ***Checklist***

OM Vol. 1, General 15.4

Starting Engines

Normal Engine Idle Indications ..OM Vol. 1, Starting 15.6

- ◆ **APU** or **EXT PWR (L) POWER IN USE** Light ....Extinguished
- ◆ **L CSD OIL PRESS LOW** Light........................Extinguished
- ◆ **L OIL PRESS LOW** Light ....Extinguished
- ◆ **L HYD PRESS LOW** Light ....Extinguished
- ◆ EGT ....300-480°C
- ◆ Fuel Flow...600-1100 pph.
- ◆ Oil Pressure ....40-55 psi.
- ◆ N2 RPM...50 -61%

Engine Start Key Notes ....STARTING 15.7-15.8

Engine Warm-up—If the engines have been shut down more than two hours, warm up engines 5 minutes at low power settings.

Starting EGT

<u>Tailwinds</u> > 20 knots
- Reverse engine rotation may occur
- Increases probability of hot start
- Closely monitor EGT and other parameters until engine is stabilized at idle RPM.

<u>Normal starting fuel flow</u>—approximately 600 pph
- Starting fuel flow ≥ 1100 pph may be indicate a hot start
  - If observed, monitor EGT and other indications
  - Move the FUEL Lever to OFF when hot start is imminent
- Observe starter duty cycle limitation while motoring

<u>Starting EGT of 465°C through 500°C</u>—
- Make a numbered Info to Maintenance entry in AML
- No Maintenance action is required.

<u>If EGT limit 500° is exceeded</u> for any period of time
- Immediately shut down the engine
- Record the peak EGT and duration of over temp in E6. Request maintenance to come out to the aircraft.

TWA For 94xx and 96xx airplanes
- Engine data on electronic Engine Display Panel (EDP)
- N_1, N_2, and EGT Indicator digits flash when a hot start is imminent or maximum value is exceeded

Idle RPM

<u>Low Idle RPM</u>
- N2 RPM < 50% *accompanied by* EGT greater than 480 *and* possible generator cycling *may be an indication* 13th stage start bleed valve has failed to close
  - ♦Momentarily advance throttle to 65% N2, then retard to IDLE.
  - ♦Start bleed valve should close,
  - ♦Normal stabilized idle engine readings should result
- If N2 < 50% or generator cycling persists, contact Maintenance

<u>High altitude airports</u>—May need to advance throttle > 65% N2
<u>High Idle RPM</u>—If N2 RPM > 67% contact Maintenance.

Post Start Overtemp

EGT is 480 – 590°C after stabilized idle
- Engine shut down is not required.
- Make AML entry

If EGT > 590°C,
- Immediately shut down engine
- Contact maintenance and make an AML entry including:
  - ◆Idle N_2 RPM
  - ♦OAT
  - ◆Barometric pressure
  - ♦Fuel flow
  - ◆Peak EGT and duration
  - ♦Generator cycling, if any
  - ◆Throttle movement, if any
  - ♦Airplane movement, if any.

Engine Abnormal Start ....QRH, ENG 7.9

Use Engine Panel for cues

Top to bottom, (including Fuel Levers)
Each item has 1 associated item to remember ***except*** <u>2</u> each for N_2 and EGT

Fire Handles—Tailpipe fire or torching..........QRH FIRE 8.41
Oil Pressure Gage— ....QRH ENG 7.28
- Pressure <40 psi or no rise ....QRH ENG 7.28, 31
- **OIL PRESS LOW** Light on after start ....QRH ENG 7.33
- <u>Note</u>—*For cold soaked engine (oil temp below 25°C), up to 5 minutes allowed for normal oil pressure.*

N_2 Gage-Air pressure to starter, no N2 rotation.QRH ENG 7.30
N_1 Gage—No N_1, confirmed by ground crew .....QRH ENG 7.29
EGT Gage—(EGT is Important, so **2** Items again)
- No EGT rise within 20 seconds of fuel lever to **ON**
- EGT > 500°C (ground) or 625°C (air).......LIMITATIONS 10.16

Items below have been removed from QRH and are included for reference only

Fuel Flow—Initial FF over 900 pph—anticipate hot start.......
- Removed from QRH
- <u>Item not on panel</u>—associate with <u>fuel</u> flow gage

Engine Start Switch—inadvertently released or positioned to **OFF** prior to 40% N_2
- Allow N_2 to decrease to zero before re-engaging
- If this occurs after fuel lever positioned to **ON**, immediately abort the start by placing the fuel lever to **OFF**..Removed

Three Lights—signal need to abort after start sequence
CSD OIL PRESSURE LOW Light remains on.......QRH ELECT 6.28
HYD PRESS LOW Light remains on ....OM Vol. 1, STARTING 15.6
START VALVE Light—Start valve did not close.....QRH ENG-7.48

QRH Starting Procedures to Review

Engine Abnormal Start Procedure ....QRH ENGINES 7.9
Engine Clearing ....QRH 7.11

Other Power Limitations..........OM Vol. 1, TAXI-TAKEOFF 10.3

One-engine taxi—avoid over 1.2 EPR for breakaway power in vicinity of gate area

To start immediate turn
Set thrust and wait for the airplane to respond
Roll forward before turning

Before Takeoff

Flaps/Slats Callout

11/ ....Closeout Flap Setting
11/ ....Flap Thumb wheel
11/..Flap Handle Position
11/ ....Flap Position Indicator
TAKEOFF..................................Slat "TAKEOFF" Light ON

Takeoff

Takeoff Bugs

WHITE V1
ORANGE V2
WHITE ....Flap Retract
WHITE ....Slat Retract
WHITE ....Clean Minimum Maneuvering
RED COMMAND ....250 Knots

Final Power Adjustment

Complete by 60 knots
Autothrottle CLMP by 60 knots or AT must be disengaged

Takeoff Attitude

8° Desired
10.5° = Tail Strike

Climb Speed Safety Margin

V_2 + 10 yields 20% margin over stall (1.2 x V_{STALL}) for bank angles up to 15°

If 30° bank is required, use V_2 + 20, which yields a 30% stall margin in a 30° bank turn

Special airport procedures listed in Part II are designed to ensure a 20% over V_{STALL} margin

After Take-Off Climb

Initial Climb Speeds

250 Knots or (clean MIN MAN, whichever is greater) until 10,000 feet MSL
120,000 Lbs or less—290 Knots until planned cruise mach
Over 120,000 Lbs—300 Knots until planned cruise mach
Cruise Mach above Mach crossover to cruise altitude

Descent

Standard Descent Speeds for Planning

Arriving at domestic US stations, plan to descend using the following descent schedule:
♦Cruise Mach to the 290 knot crossover altitude
♦290 knots to 10,000 feet
♦250 knots or less below 10,000 feet

Outside domestic airspace, consider an optimum (CI generated) descent speed into those destinations where experience and judgment indicate no ATC conflict.

Airspeed Bug Settings

WHITE ....0/Ret—Min Maneuver
WHITE ....0/Ext—Min Maneuver
WHITE ....15/Ext—Min Maneuver
....11/Ext if required by Airport Analysis
COMMAND BUG ....Approach Speed
For all conditions unless specified in abnormal procedures.....
Between V_{REF}+5 and V_{REF}+20
A/T OFF—V_{REF} + greater of: ....5 Kts (VREF + 5)
....***or*** 1/2 steady state wind above 20 Kt
or all of the gusts above steady winds
A/T ON...........ATS speed 5 knots less than computed speed
....with corrections above, not less than V_{REF}+5
Autolanding ....V_{REF}+5 with no wind additives
See OM Vol. 1, CL-CRUISE-DES-20.5
ORANGE ....VREF
WHITE ....80 Knots

Before Landing

Flaps & Slats Callout

40/ ....Flap Handle Setting
40/ F ....Flap Position Indicator

Landing

Landing Flap Selection APP-LDG-G/A-10.2-10.3

Flaps 28° and 40° are normal landing settings

Flaps 40° *Required* for anti-skid INOP
Recommended when:
♦Runway ≤7000
♦Runway wet/slippery
♦Braking action less than good
♦Tailwind, crosswinds, or gusty wind (*velocity not specified*)
♦A/C weight very light (not defined)
♦Steeper than normal approach due to ATC requirements

Auto Brake Landing Settings ....APP-LDG-G/A 15.3

Required when:
♦Runway <7000'
♦RVR <4000' or visibility <¾ mile
♦Runway contaminated (standing water, snow, slush or ice)
♦Braking action reported less than good
Recommended when:
♦Landing with "gusty winds or crosswinds" or tailwinds

Setting selection: "Autobrake settings should be appropriate to the conditions: **MAX** must be used when minimum stopping distance is required."
OM Vol. 1, APP-LDG-G/A-15.3, 30.5, 40.3

Thrust Reverser Considerations ....APP-LDG-G/A 45.3

With spoilers deployed *and* directional control assured reverse thrust <u>may be left at idle</u> *or* <u>increased</u> to a target of approximately 1.3 EPR

Application of reverse thrust tends to blank out the rudder
Rudder effectiveness starts decreasing with the application of reverse thrust and at 90 knots
A 1.6 EPR (in reverse) rudder is almost completely ineffective

Reverse thrust > 1.3 EPR should not be used unless stopping distance is in doubt

Do not exceed 1.3 EPR reverse thrust on wet or contaminated runway, except in emergency, when max reverse thrust may be used

If the airplane starts drifting across runway while reversing,
Immediately return thrust levers to idle reverse to regain directional control and restore rudder effectiveness.
Do not use asymmetrical reverse thrust to regain directional control
Reapply reverse thrust when directional control is restored.

When using more than idle reverse thrust, rapid movement of the reverse levers to the stowed position will cause the airplane to accelerate as the engines are decelerating to idle RPM.

CAUTION
Moving the Reverse Levers to reverse idle prior to the nose gear being firmly on the runway may cause the reverse buckets to contact the ground.
The combination of forward airplane movement and reverse thrust at airspeeds below 60 knots results in an airflow capable of causing ingestion of runway / taxiway debris into the engines. This condition should be avoided whenever possible.

Manual Braking...................APP-LDG-G/A -45.4, 50.11

Whenever practicable, do not use brakes above 100 knots
If stopping distance is critical, or other abnormal conditions exist, brakes may be used from touchdown to full stop.
See additional notes, page APP-LDG-G/A 50.15

Approach Techniques

Initial Setup..**WARM**
- Weather requirements ....Check
  - Include crosswinds, visibility, published minimums
- Approach.................................Plan and Brief Approach
- RNP ....Check Chart and set as required for the approach
- MCP—When cleared for the approach ....Select APP Mode
  - ....Set FAF altitude when on intercept *or* a portion of the approach

Captain Callouts.................LOC / GS Intercept / Passing FAF
Passing FAF Actions...**MAC-V**
- Missed approach Altitude ....Verify Set
- APPR Light—Green (RNAV Approaches) ....Verify
- Clearance—Tower.................................Call Passing FAF
- V/S..Set as required

Note: *This section compiled from instructor notes and various OM references; NOT procedural, but technique recommendations.*

Approach Deviation Callouts

Airspeed error exceeds −5 or +10 knots
Rate of Descent

When Below:	If Descent Rate Exceeds:
2000' AFL	2000 fpm
1000' AFL	1000 fpm
Inside FAF	1000 fpm

Localizer and Glide Slope
- Localizer— 1/3 Dot on PFD localizer indication.........***COURSE***
- Glide Slope—1/2 Dot on glide slope..................***GLIDESLOPE***

RNAV GPS / GNSS
- Course—1 dot deviation...................................***COURSE***
- Vertical deviation < 1,000' AFL— 1/2 Dot on VDI....***GLIDESLOPE***

Other Approaches & Parameters ....OM Vol. 1, APP-LDG-G/A 20.4

Briefings and Restrictions

Flight Attendant Briefing—Prior to gate departure

Number of F/A's on board
Known delays
Ground—Short-taxi & safety demo considerations
Turbulence
- Weather and turbulence forecast for route
- Unexpected turbulence
- Notification
- Required action in the event of a significant encounter
  - Service suspension at F/A's discretion
  - When able, call CA to report cabin situation / injuries
  - No access to interphone—stay seated, avoid injury
  - Resuming Duties
  - Once cleared to resume call flight deck to report any injuries or abnormalities.

Security items
E6 Cabin Items
Life vest demo—overwater segment
Gen Decs/Customs Immigration forms (if required).
Cockpit Access—Crew meals / Cockpit Door
Cabin Door Handles—Push Down
Miscellaneous—Issues relevant to flight ....FM Part 1, page 7.1-3

Restricted Captain Requirements ....FM Part 1, 4.2-1

Applies if
- CA has < 100 hours after IOE in current aircraft type
- Required 100 hours PIC in aircraft type may be reduced not to exceed 50% by substituting one landing for one hour of PIC time in aircraft type.

Restrictions *unless* FAA Exemption 5549 apply
- ♦ Chart increases required visibility ....FM Part 1, 4.2-1
- ♦ Alternate Airport - Published minima need not be increased, but lowest allowable landing minima is 300 feet MDA/DH and one mile visibility or 4500 RVR / 1400 meters

Practical Effect of Exemption 5549:
- Recognizes inherent safety of autopilot coupled approaches
- Allows approaches using
  - ♦CAT II procedures to no lower CAT published minima or
  - ♦CAT I procedures to published CAT I MDA, no lower than RVR 1800'
- See detailed charts ....FM Part 1, pp. 4.2-1 to 4.2-3

Low Experience FO: <100 Hours (CFR 121.438)

When Applies—FO has <100 hours flight time as SIC in type aircraft being flown, ***and***
Captain (PIC) is not a qualified Check Airman,

PIC must make all takeoffs when:
- All special requirement airports
- Visibility in the latest WX report at or below 3/4 mile
- RVR for the runway to be used is at or below 4000 feet
- Runway has water, snow, slush, or similar conditions which may adversely affect A/C performance
- Braking action is reported less than good
- Crosswind component >15 kts
- Windshear reported in the vicinity of the airport
- Any other condition PIC determines prudent....FM Pt. 1, 4.2-4

Flight Attendants—Emergency TEST Acronym

T—TYPE of emergency: General description of the emergency
E—EVACUATION: Yes or No
- Include any special considerations which may affect the use of exits.

S—SIGNAL: the following PA:
- **"This is the Captain. Evacuate. Evacuate. Evacuate."**
- Followed by turning on Evacuation Command (as installed).

T—TIME to landing.........................QRH MISCELLANEOUS 0.11
....FM Part 1, 19.2.3

Emergency PA to Passengers

Nature of emergency
Time to landing
Passenger cooperation with Flight Attendants
Reassure passengers. ....QRH MISCELLANEOUS 0.12

Cold Weather Operations

Cold Weather Operations and De / Anti-icing Guidance
.......OM Vol. 1, GENERAL 30.1 to 30.22 and 31.1 to 31d-5

Icing Definition—Ground or Flight

Ground or Flight RAT—Below 6°C / 42°F
***AND* Visible moisture present** such as clouds, fog with visibility one mile or less, rain, snow, sleet, or ice crystals.
- ***OR*** (Ground only) Temperature as above ***and*** temperature-dew point spread is 3°C (5°F) or less
- ***AND*** Any form of moisture is present (standing water, snow, slush etc.) ***which may be***
  - Ingested by the engines and freeze on engine inlets, nacelles or engine sensor probes

Preflight

Advise Dispatch if RLW needs adjustment
Special Attention **for ice in:**
- ♦Wheel wells, actuators & steering components
- ♦Flight controls (flaps, slats, control tabs, etc.)
- ♦Wing surfaces (Max 1/8 inch frost on bottom
- ♦Pitot-Static components
- ♦Engine Inlets
- ♦Pack inlet/exit doors
- ♦Fuel tank vents
- ♦Pressure reg./relief valves
- ♦APU Inlet

Check area behind overwing heater for ice runback and lower wing surfaces for icicles.
Upper wing surface inspection required by cockpit crewmember when in Cold Weather temperature range
Operative Overwing Heater System does not relieve flight crew of requirement to check airplane surfaces free of frost, snow, and ice accumulation, as required by FARs
Physical feel (pole) check required if heater blankets inoperative and the temperature is less than 10°C (50°F) and high humidity or visible moisture is present.
Frost on the bottom of the wings under the fuel tanks may occur when the fuel temperature is low, OAT is above freezing and humidity is high

Deicing

Packs and Bleeds (Engine & APU) OFF During and for 1 minute after deicing
APU—May be ON
Engines If operating, at idle power
Before T/O Checklist Must be completed in entirety following deicing

Start/Taxi

Caution: *If frozen contamination in intakes, must be removed by certified deicing personnel.*
Engine Start—Ensure normal N_1 during start
Oil Pressure may be high due to low OAT
♦Must be in normal range when oil temperature stabilizes in normal range
♦Operate at idle until oil pressure reaches normal range
Engine Anti-Ice ON Immediately after start if icing conditions exist or anticipated before T/O
Ignition **CONTIN A** or **B**
Flaps & Slats Up until just before takeoff ***if***
Taxiway contaminated *or*
Freezing precipitation continues after deice/anti-ice
Caution—*Monitor flap indicator for early stop*
Flight Controls—Check for full travel of flight controls
Periodic engine run-up recommended no more frequently than every 10 minutes
70% N_1 for 15 seconds or 60% N_1 for 40 seconds
Use caution for *jet blast*
Any Precipitation after holdover time—visual inspection required (*Cockpit observation of wipers, etc., —use to determine need for ext. insp.*)
Fuel Heat before takeoff if fuel <0°C
One minute each
First engine stabilized before starting heat on second engine at a time
Fuel heat off for takeoff ....OM Vol. 1, SYSTEMS 65.1

Contaminated Runways

A runway should be considered contaminated when:
More than 25 percent of the required field length, within the width being used, is covered by:
♦Standing water, slush, or wet snow deeper than 1/8“ (3 mm)
♦Dry snow deeper than 1 inch (25 mm),
♦Ice.
If a runway is contaminated:
♦Takeoff is not authorized with a tailwind
♦Takeoff is not authorized with
♦♦More than 1/2 inch of wet snow, slush, ***OR***
♦♦Standing water, ***OR***
♦♦More than 4 inches of dry snow
♦Maximum thrust must be used
If ART (MEL item 73-8) is inoperative use Reserve thrust. Standard thrust is not authorized
♦Both thrust reversers must be operative
♦APU will be used for takeoff, if operative.
♦♦APU Air Switch is **OFF**
♦♦APU Bus Switches are **ON**)
♦Takeoff not authorized with chunks of hardened snow or ice
♦Corrections to V1 and maximum weight allowances are made by dispatchers and sent to aircraft
Performance, TAKEOFF 40.1
See also page 54 of this Study Guide

Takeoff

Runway Is unfit for takeoff if:
>4" Fresh, dry snow
½" Standing water/wet snow/slush
Chunks of ice or hardened snow ....PERF TAKEOFF 40.1
Run Engines Up to 1.4 EPR or 80% N1 and check for normal indications prior to brake release
Align A/C with runway before T/O Power is set
Cross-Check Engines instruments for “reasonableness”
Asymmetric Thrust—Avoid (directional control)
Rotation—Slow & smooth—avoid abrupt or early
400' or Above—Packs ON IAW CL-CR-DESC p. 10.4
1000' or Above—Wing Anti-Ice ON ....Performance, TAKEOFF 40.1

Climb, Cruise, Descent

Sufficient Thrust to keep L or **R ICE PROTECT TEMP LOW** Light out
Watch for Drop in thrust parameters (Icing of PT2 probe indications)
Airfoil Anti-Ice min duct pressure 20psi
Tail Deicing cycled every 20 minutes
Fuel Heat and tail deice cycle 1 minute prior to approach
Severe Icing conditions—
Ignition OVRD
Minimum N1—70%
If N1 reduction is necessary, no lower than 55%
After reduction, N1 to 75% when able for 1 minute (minimum)

Landing

"In the Slot" extremely critical with poor braking
♦≈250' at ¾ Mile Final
♦Sink Rate Appropriate
♦Aligned with Runway
♦Final Landing Configuration
♦On Glideslope
♦Trimmed Up
♦Thrust Steady
40° Landing recommended on wet or slippery runways
If a landing on a runway contaminated by standing water, slush, snow or ice:
♦APU (if operative) will be started and
♦Left and right APU bus switches ON prior to final approach.
Serves as backup electrical power source in case the engine driven generators are lost due to slush or water ingestion by engines and subsequent loss of engine RPM
Recommended techniques:
♦Land on speed.
♦Touchdown at the planned point
♦A firm landing is better than a “grease job.”
♦Keep nose wheel firmly on runway with elevator.
Caution: *Excessive down elevator force will download the main gear and reduce braking efficiency.*
♦Use maximum auto brakes or aggressive manual braking and auto spoilers, if available
♦Maintaining directional control is the highest priority
♦Apply reverse thrust
As soon as possible after nosewheel touchdown.
Do not exceed 1.3 EPR reverse thrust on the slippery portions of the runway, except in an emergency
♦When reversing, if directional control is lost:
Reduce reverse until control is regained
Use forward idle thrust if necessary
♦Do not come out of reverse at a high RPM
Sudden transition of reversers before engines spool down will cause forward acceleration.
♦Use as much of the runway for roll-out as needed to slow airplane to a safe taxi speed before turning off a wet / slippery runway.
CAUTION: *In an emergency, use maximum reverse thrust, if required, to stop in the remaining runway.*Runway Unfit for landing:
1' of Standing water, wet snow, or slush
Chunks of ice or hardened snow
Plan Firm Touchdown
Use Auto brakes/Auto spoilers
Apply Reverse Thrust ASAP after nosewheel touchdown:
Don’t exceed 1.3 EPR on slippery portions of the runway except in emergency.
In emergency, use maximum reverse thrust if required to stop in remaining runway

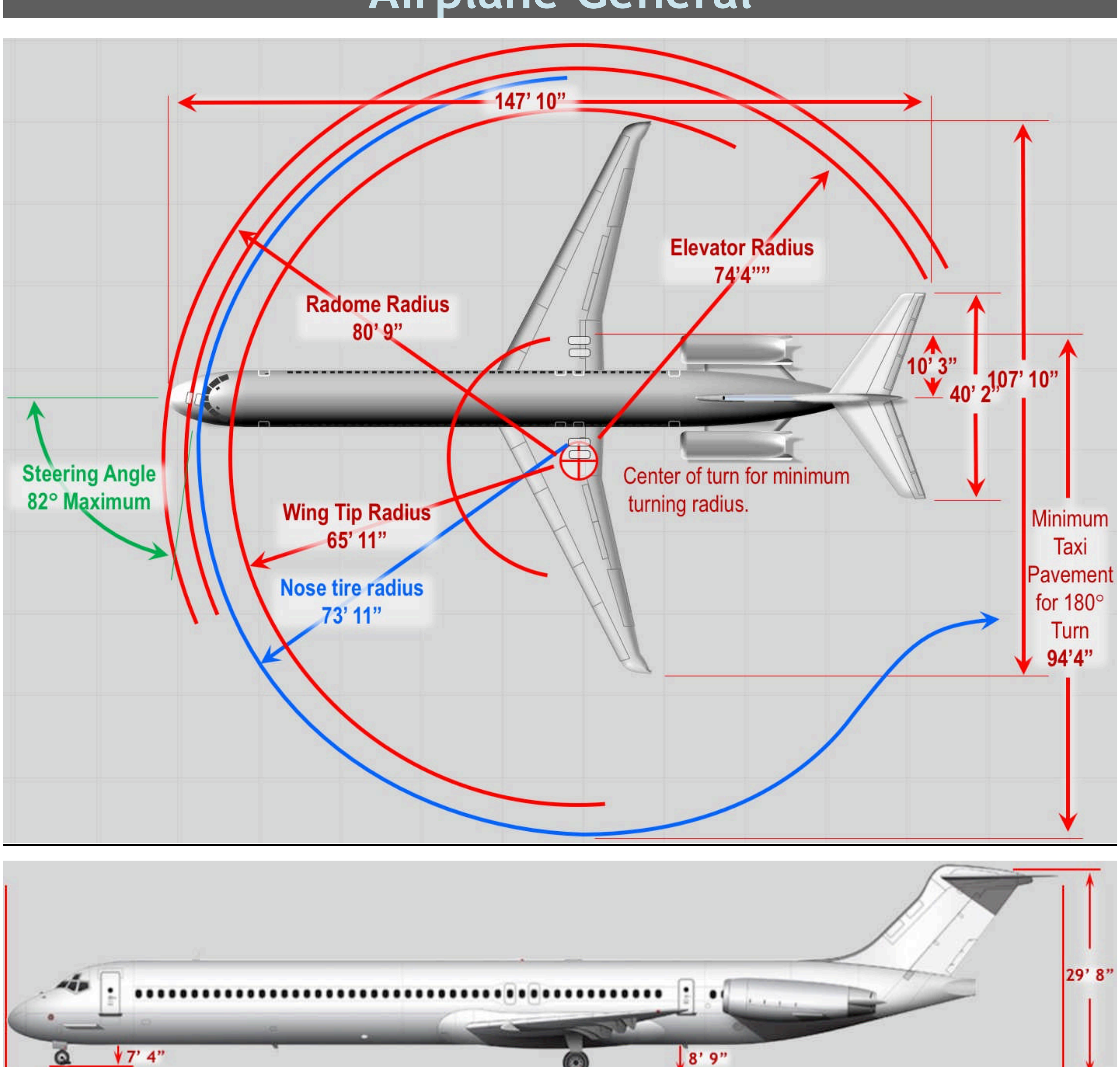
Taxi In & Parking

If Slush Or Snow on runway or after making an approach in icing conditions:
Leave flaps 15°
Call station for inspection by maintenance
Draining Water System required if
A/C Parked overnight in freezing temperatures
Lavatory fluid must be drained or treated anti-freeze
Call Dispatch to report runway conditions if appropriate
Call Station to coordinate inspection of flap area

References

OM Vol. 1, GENERAL 30.1 - 30.38,
OM Vol. 1, LIMITATIONS 10.28-10.30

Airplane General



Side Silhouette drawing courtesy of ***Norebbo Stock Illustration and Design***, www.norebbo.com.

Air Conditioning and Pressurization



General

System Components

2 Air conditioning-pressurization units (packs)
- One on each side of the aircraft
- Normally, air supply from respective engine

Pneumatic Crossfeed Valves allow:
- Air from one side to run the pack on the other side
- The APU to supply air for either or both packs
- The engine to supply air to the airfoil anti-ice system

2 Independent/redundant pressurization controllers alternate roles as primary/backup each flight

Manual outflow valve control backs up electronic controllers

Positive relief valves prevent over-pressurization

Negative pressure relief through
- Inward movement of galley & passenger door seals
- Negative pressure relief valve on aft pressure bulkhead

AC—Pressure Regulated, Temperature Protected

AI—Temperature Regulated, Pressure Protected

Pack Automatic Shutdown Circuit

Shuts off both packs if engine fails on takeoff

Arming—after engine start when: (EPAD)
- *Engines—one or both running*
- *Pack Supply Switches (1 or both) HP BLD OFF or AUTO*
- *AUTO selected—Air Conditioning Shutoff Switch*
- *Differential Pressure (cabin to ambient) < 1.3 psi*

Activation:
- Differential 13th stage pressure (delta P) of 70 psi or more as failed engine spools down
- False activation can occur on single engine taxi with high power

Deactivation: Remains armed on ground and airborne through approx. 3000 feet AFL (1.3 psid point reached)

Reset—Air Conditioner Shutoff Switch to OVRD

System Inop—Make No Pack Takeoff

Pack Control

L and R Supply Switches AUTO
- Opens Flow Control and Pressure Regulator Valves to let air into the packs
- (Ground) Turns on Pack cooling fans for respective side

HP BLD OFF Position:
- Opens: ♦Pressure Regulator Valve ♦Flow Control Valve
- Closes: ♦Augmentation Valve
- ♦*Ground only*—Heat Exchanger Cooling Fan **ON**
- Keeps 13th Stage air out of system by maintaining augmentation valve closed
- Starts heat exchanger cooling fans

Desired output pressure—approx. 21 psi
- With engines running—13th stage augmentation valves modulate as necessary to augment 8th stage air
- With APU running—APU load control valve regulates air pressure output

Packs

Pack cooling fans
- Draw air across primary heat exchanger on ground with supply switches ON
- Cooling air diverter valve closes when fan is on

Overheat protection
- Thermal shutdown switches sense excessive temperatures in:
  - Compressor discharge
  - Turbine inlet
  - Outlet duct
- Result—Air conditioning flow control valve closes, effectively tripping the pack
- Reinstatement is automatic when temperatures return to normal
- No pilot action is necessary or available

Low-flow protection
- Pack may shut down if lower than 12 psi output sensed
- With flow gages—9 O'clock position

Air Sources:

Ground Pack Air Sources
- ♦Engines ♦APU ♦External high-pressure air

Other conditioned air source: External pre-conditioned air

Airborne Pack Air Sources
- Engines
  - Either can supply sufficient air for both packs
  - Pneumatic crossfeeds allow airflow to opposite side
- APU—***not*** available
  - In-flight use is for electrics only
  - No airborne bleeding of APU air is allowed

Air Conditioning

Dual Temperature Controls

Manual and Automatic ranges

Normal air distribution
- Right pack supplies air to cabin
- Left pack controls air to cockpit and cabin

Recirculating Fan

AIR CONDITIONING RECIRCULATION FAN — OFF / ON / AUTO

Recirculates Cabin Air

Increases flow rate and reduces hot/cold pockets

Cockpit control:
- Recirculation Fan Switch
  - **OFF**—Self Explanatory
  - **ON**—Allows recirculating fan to operate on the ground to supplement air conditioning
  - **AUTO**—Off on ground, On in flight

APU Ground Cooling Use

All aircraft now modified with -280 APU and should provide sufficient airflow for cooling on ground

APU Air Switch AIR COND COLDER Position
- ♦Closes turbine bypass valve
- ♦Increases differential pressure across air conditioning turbine, lowering temperature of conditioned air
- When using APU to supplement engine air, do NOT select **AIR COND COLDER** Position ....Vol. 1, PRE-FLIGHT 10.7
  - (**ON** Position provides best combination of air flow and refrigeration for this condition)
- When using APU for electrical power, with two A/C units operating may exceed 1.25 AC Loadmeter limit

See Volume 1, SYSTEMS-15.3

Manual Temperature Control

CABIN TEMP AUTO — COLD / HOT — STOP MANUAL

Manual range on auto-manual temperature control rheostat

Max gage temperature is 150°F
- Do not exceed 150°F in supply duct
- Pack output >190°F (no indication) trips pack

Operation in MANUAL mode—
- *Not recommended* unless the automatic system has failed

Note: CKPT TEMP Valve movement is inhibited toward hot if left pack discharge temperature exceeds 130°F. Resets when temperature drops back below 130°F.

Pressurization

Key Pressures & Altitudes

1.3 psid—Over 1.3 psid prevents arming of the Pack Automatic Shutdown Circuit

7.5 psid—Manual pressurization maximum stable pressure

7.77+.3 psid—Normally programmed maximum pressure

7.77 psid— TWA Maximum Cabin Differential Pressure

8.07 psid—Maximum Cabin Differential Pressure

8.32 psid—Maximum Emergency Pressure Relief

10,000 Feet Cabin Altitude—CABIN ALT Warning light, Modulating horn for 1 second, followed by *"CABIN ALTITUDE"* aural warning (May come on ≈9,500')

Fasten Seat Belt signs illuminate automatically when **CABIN ALT** Warning light ON

10,000' MSL—Maximum Dispatched altitude for Unpressurized Flight

14,000' MSL—Maximum altitude following an in-flight depressurization **14,000' Cabin Altitude (Approximate)** —Passenger Masks deploy

25,000' Cruise Altitude—Max for dispatch, single pack

Cabin Climb & Descent Rates

With rate knob on index:
- Approx. 700 fpm climb
- Approx. 300 fpm descent

Range of control
- Climb—100-2000 fpm
- Descent—40-860 fpm

Pressure Controllers

Automatically trade legs—Changeover occurs at each landing

Designated "Primary" and **"Standby"** respectively

Powered by separate AC buses

Standby continually monitors pressurization as controlled by the primary pressure controller

TRANSFER LOCKOUT / STDBY ON

If a primary controller discrepancy occurs:
- Standby system takes over
- **STDBY ON** light comes on
- **TRANSFER LOCKOUT** light comes on
  - Reset should not be attempted if **STDBY ON** light is also ON
    - If **STDBY ON** is ***not*** illuminated, ***and*** there is no fault in the standby system, ***then*** pressing **TRANSFER LOCKOUT** light will reset the automatic transfer capability

If both lights come on in flight—
- Cycle system to STDBY and back to PRIMARY
  - If STDBY ON light goes out, fault has cleared and control returned to primary controller
    - May have been caused by explainable anomaly such as:
      - ♦Power fluctuation
      - ♦Situationally-driven pressurization abnormality such as an unusually high rate of descent
    - Primary system may be used; reset **TRANSFER LOCKOUT** light
  - If **STDBY ON** light stays on
    - Primary system has failed
    - No further crew action required
    - No reset of TRANSFER LOCKOUT should be attempted in flight to allow maintenance to troubleshoot

If TRANSFER LOCKOUT Light ON by itself
- Discrepancy sensed in the standby controller-
- Corrective action:
  - Attempt Reset
  - If light stays on—STDBY system has failed
  - Further resets should not be attempted

Cabin Pressure System Selector Switch

AUTO INOP / AUTO 1 INOP / AUTO 2 INOP

- Selecting either 1 or 2 makes that the primary system
- Remaining system is standby
- Standby system fully monitors itself
- If selected system fails
  - Blue **INOP** light illuminates
  - Cabin pressure control transfer to remaining system is automatic
- Auto Switching
  - Occurs after landing
  - Primary relinquishes control to standby for 30 second test
  - Selected system then takes control back

If both systems fail—AUTO INOP light (*Amber*) .... TWA

Note: *Discussion of abnormals is for systems description only. Refer to QRH, AIR-5 for specific procedure.*

Both the TRANSFER LOCKOUT & **STDBY ON** lights are *inoperative* with the Cabin Altitude Control Lever in the **MANUAL** (Down) position

Cabin Pressurization Initiation

Occurs at takeoff power on the ground
If throttles are retarded or **no takeoff 60 seconds after power up**—depressurization occurs
System re-pressurizes with no crew input on next power up occurrence
Displays on Cabin Climb Gage

Outflow Valves

Two moveable exhaust doors
Cabin Air Outflow Butterfly Valve—Controls pressurization at low differential pressure
Cabin Air Outflow Nozzle—Used at high velocity to reduce drag
Manual control
Both outflow valves de-clutched from actuator
Valves are mechanically interconnected to sequence properly

Cargo Compartment Pressurization & Temperature Control

Pressurization—All compartments pressurized by intermittent action of cargo compartment pressurization equalization valves
Temperature
Forward—May be heated by radio rack exhaust air ducted under lower cargo liner
Mid—Heated by passenger compartment exhaust air
Ducted under lower cargo liner
Continuously circulated by a fan
Aft—No temperature control

LDG ALT Control

Set field elevation for departure or landing altitude as appropriate
NOT like some controllers, where destination elevation is set prior to departure

Warning Lights & Other Systems

Flow Light

Non-TWA Aircraft—Flow light not used
A placard-**FOR MAINTENANCE USE ONLY** is installed over the Flow light


Indicates cabin climb with fully closed outflow valve
Likely causes
Insufficient air conditioning ***OR***
Excessive fuselage leakage
Should be monitored in normal system scans......... **TWA**

Pressurization Flow Light MC

Light on in flight
Cabin is climbing with a fully closed outflow valve
Remains on until cabin pressure air flow is attained
Light is tested during the normal Annunciator/Digital Light test on preflight
Has replaced old **FLOW** light on all airplanes
Light illuminates when **LTS TEST** Button is selected.
Illuminates when tested, but deactivated.................. **TWA**

Tail Compartment Temp High Light MW



Tail compartment temperature is higher then normal
Emergency procedure eliminates all sources of 13th stage bleed from the system

Air Conditioning SUPPLY TEMP HIGH Lights MC



Lights come on when L or R air conditioning supply temp is over normal operating temperature. Indicates malfunction of the augmentation valve

Ram Air Switch



ON—Opens ram air valve
Admits ram air to conditioned air ducts in right A/C system at a point upstream of the mixing chamber
OFF—Closes Ram Air Valve

Radio Rack Fan Switch

Inoperative on ground
Primary and standby fans **ON** regardless of switch position
Venturi closed
Flight
FAN—
Primary fan ON,
Standby fan OFF unless primary fan fails, then ON
Venturi closed
Cools radio rack
Heats forward cargo compartment for animals and plants
VENTURI—
Both fans OFF
Venturi open
Cools radio rack
Does not provide heat to forward cargo compartment
Supplemental heater
Only primary fan has one
Standby fan does not have a heater and will not heat cargo compartment

RADIO FAN OFF Light

Ground—Primary fan is inoperative
In Flight—
Radio rack switch is in fan
Both primary and standby fans are inoperative

Cabin Altitude Light (Red) MW

Comes on when cabin pressure exceeds 10,000' pressure alt.
When light comes on:
- .Warning horn & aural voice warning alternately sound for 5 seconds (1 second each, alternating)
  Aural Warning ....CABIN ALTITUDE
- .Cycle continues for 5 seconds or until condition is corrected, whichever occurs first
- .Fasten Seat Belts signs come on in cabin, as well.

Instrument Airflow Indicator (Ground operation only)



ON—Indicates flow is sensed to instrument panels
OFF—Indicates failure of instrument cooling fan
Above Gear position indicator lights on F/O panel
Note: Indications significant only on ground with normal electrical power applied and air conditioning **OFF**.

APU—Auxiliary Power Unit



General—Source for:

Pneumatics	Electrical
Air Conditioning	Ground—normal aircraft functions
Engine Start	Airborne—alternate electrical power

Fuel

Primary source—right main tank
Boost pumps which supply fuel to the APU
DC Start pump—"Short Life" pump
Used when only battery power available
Normally only used for starting
Any right main or center tank boost pump
L main tank boost pump with crossfeed valve ON
Normally used—RH Aft Fuel Boost Pump

Bleed Air System

Bleed air source—port on APU turbine plenum housing
Bleed airflow—selected On-Off in cockpit
One-way valve prevents reverse flow from engines to APU
Electronic Control Unit (ECU)
Controls bleed pressure without loads to 15-22 psi
With a pack or engine start valve energized open, pressure increases "to its normal operating range for this condition within 6 seconds"

Electrical vs. Bleed Air Load

Electrical load has higher priority than bleed air
With excessive EGT, load control valve restricts bleed air

APU Inlet Doors

1 Ram Air Door—allows ram air to assist APU RPM acceleration for airborne starts
2 Smaller non-ram air doors
May be sequenced automatically or manually
Door control sequence:
APU Master Switch to START
Ram air door opens; Power is routed to APU Starter
35% RPM—ECU switch removes power from starter
95% RPM—Ram air door closes as non-ram doors open
Doors remain in this condition until APU shutdown
Door Control—DC Transfer Bus

Automatic Warm-Up/Cool Down Timer

Prevents bleed air load until 60 seconds after 95% RPM
APU Master Switch OFF—60 sec. APU shut down delay
Fire control switch OFF & AGENT ARM bypasses 60-second timer

APU Automatic Shutdowns (FOIL'D)

Warning Lights: All light the Master Caution/Warning Light **MC** **MW**

♦**APU Oil Press Low** light **MC**
Self explanatory

♦**APU Fire—**APU Fire Detection System is activated. (See OM Vol. 2, FIRE PROTECTION-5) **MC** **MW**

APU FIRE
APU FIRE

♦**APU Fault—**Simply says a fault has been detected **MC**

APU FAULT

Ground—Automatic shutdown, or no start

Airborne—APU Runs until ≈ 10 minutes after landing unless these faults are sensed ***FOIL'D***

Fire (APU)	**D**C Power loss
Overspeed	
Internal Fault	For any of these five,
Loss of speed sensing airborne	shutdown occurs

APU Start Notes

Electric start capabilities up to 37,000 feet
Max electric start capabilities up to 30,000 feet
Max operating altitude 35,000 feet .... **TWA**

OM Volume 1, Systems 20.2

Air starts
Ram-air-assisted electrical start
No electric power—starter locks out; ram air only
Both AC Generator Buses unpowered—electric starter locks out for windmill-only start
Windmill Starts—No RPM indications may occur for over 1 minute; complete cycle may take in excess of 2 minutes
Battery required ON for start & APU running—APU control CB-battery bus
Should check bus control circuits OFF before start
RAM AIR and air conditioning SUPPLY switches must be OFF prior to start ....OM Vol. 1 PRE-FLIGHT 10.5
Momentary EGT/RPM gage deflection on start is normal
May take up to 55 seconds after first RPM indication to reach operating RPM (Don't mistake for hung start)
Starter Duty Cycle begins at first indication of APU RPM
Put MSTR Switch in RUN, wait 1 minute, then **START**
RPM Indication should occur immediately
APU Low Oil Pressure light on (out by 35% RPM normally, must be out by 95%—see below)
No Start or Hung Start
Indications of Hung Start:
RPM Stabilized below normal range (95-105%)
EGT rising or near maximum
Shut down with **APU MASTER** Switch ....QRH APU-2 & APU-3
By about 95% RPM:
♦Power Available Light **ON** (Blue)
♦APU OIL PRESSURE LOW Light out
♦Door Sequencing should be complete
♦Ignition cuts out
♦Timer begins for 60-second bleed air delay
"Normal" APU EGT—200-400°C or 60-70% With **APU AIR** switch **ON** & all pneumatically powered systems off...QRH, p.3 APU-2
Note: *Only one reset of APU generator permitted for each APU start*
If the APU generator does not reset, contact maintenance and make an E-6 entry ....OM Vol. 1 PRE-FLIGHT 10.6

Autoflight

Editor's Note: *No attempt is made here to describe the autopilot system in detail. That would be beyond the scope of this document. Only key highlights which are easily missed or forgotten will be covered here for review. It is assumed that most pilots interact with this system sufficiently on a day-to-day basis to be familiar with its operation. In addition, the FGS Trainer at the Flight Academy does an excellent job of introducing this system.*



General

Limitations—Review OM Volume 1, LIMITATIONS, pages 10.12-13 for numerous items

Autopilot (AP)

Disconnecting AP

Hold control yoke when disconnecting AP

If trim input is made while AP is engaged:
- AP would compensate
- When AP disengaged, abrupt control input could result

Verbal callout is required when disengaging AP ***or***
- if AP is observed to have disengaged itself

OM Vol. 1, SYSTEMS 25.9

Heading Split

±2° or Greater split causes
- Flight director V-Bars to bias out of view
- AP disconnect
- NO AUTOLAND lights illuminate

Above functions return to normal when split is eliminated

If heading is 360° ± 3° at time of split, functions not operational until heading changes from 360° by at least ± 5°

Engine Failure on Takeoff Logic

Loss detected <u>below V_2</u>—V-Bars command and AP controls pitch to accelerate to **V_2**

Loss detected <u>between V_2 and V_2 + 10</u>—Target pitch is used to hold **airspeed constant**

Loss detected <u>above V_2 +10</u>—Target pitch is used to slow to **V_2 +10** (trade airspeed for altitude)

Engine Failure Logic (AD 92-10-13 R1)

Armed if
- (1) the flight director pitch axis is in takeoff mode,
- (2) the aircraft is above 350 feet radio altitude, and
- (3) both engine pressure ratios (EPR's) are below the go-around EPR limit

If the DFGC detects an EPR drop
- ≥ 0.25 EPR ***and*** ≥ 7% N1 compared to the other engine ***then***
- Engine failure logic is satisfied ***and***
- DFGC will change the Thrust Rating Panel (or indicator) thrust limit to Go-Around (GA)
- This will cause the autothrottle system to unclamp and enter normal EPR limit (EPR LIM) mode where the throttles will maintain the higher engine EPR at the selected go-around thrust rating EPR LIM
- Such an EPR and N1 drop may also result from an engine surge (stall).
- Advancing thrust levers on a surging engine will hinder surge recovery and may result in eventual engine failure.

If an engine surge (stall) is detected during takeoff:
- Follow procedures in OM Vol 1 for Engine Stall/Surge after TO

Flight Guidance Differences

FMS OVRD Button replaces **BACK CRS**

VNAV Button replaces **PERF**

See TWA Supplement for other FGS differences............... **TWA**

Autothrottle (AT)

Autothrottle Clutch Mechanism

Allows manual throttle movement with AT on, *but*
- Wears clutch mechanism excessively
- Maintenance repair takes extensive time

To avoid, throttles should only be manually positioned with FMA throttle window **CLMP** or **LOW LIM**

FD
CADC

CADC Light—See *page 40 of this study guide*

FD Light—FD CMD Selector is out of the **NORM** position.

Other Systems

Yaw Damper

Activated when:
- Yaw Damper switch is ON
- or
- Yaw damper switch is OFF but Autopilot is Engaged

Deactivated when switch is in **OVRD**

Rudder movements generated by the Yaw Damper are not transmitted to rudder pedals

Autopilot *will* engage with yaw damper deactivated (Switch in **OVRD**)

Altitude Alert

Deactivated at glide slope capture

Reactivates for go-around (if required) when glide slope signal lost during missed approach

EFIS

Excessive pitch chevrons appear at:
- +25° Pitch
- -7° Pitch

Full deflection on Fast/Slow display equates to approximately 10 Knots

There is *no failure warning* for marker beacons INOP

<u>Note</u>: If EFIS display goes full bright—indicates a problem with the dimming circuit which is uncorrectable.

Flight Mode Annunciator

Four Columns of displayed information—
TARP
- **T***hrottle*
- **A***rmed*
- **R***oll*
- **P***itch*

THROTTLE | AP | RE SET
ILS | HORIZON | HEADING
NO AUTOLAND | AP TRIM | MONITOR
CLMP | 050 | TAK OFF | TAK OFF

Autothrottle Mode	"Armed" Display	Roll Mode	Pitch Mode

Reset Button
- Allows reset of all the amber lights in the diagram above except the **AP TRIM** indication

Communications



General

Two separate transmitter/receivers for VHF
#1 Radio—on Emerg DC Bus; normally used for ATC
#2 Normally used for ATIS, Company, Ramp, etc.

Some aircraft require boom microphones below 18,000 feet MSL

Selective Calling (SELCAL)

Two monitors, each tuned to one VHF radio

SELCAL 1 monitors **VHF 1**

Each looks for coded signals indicating a call to the aircraft

If received, SELCAL cues the Central Aural Warning System (CAWS)
Light for appropriate SELCAL is lit
Chime sounds

Chime Reset: Push SELCAL light

Interphone and PA

Microphone selection—Very straightforward design
Light comes on and button of mic selected remains depressed to indicate which is currently selected
Only one mic selection may be made at a time

Pushing PA mic selection allows PAs to be made with the O_2-mask on

Cockpit speakers are muted during transmissions from CA or FO positions to prevent feedback

Mode S Transponder

Ground Operation
Ground control relay inhibits some functions while aircraft is on the ground (*instructor note*)
"R" Reply indication comes on if ATC 2 is selected and system is interrogated
Not required on Mode S transponders
Does not function with ATC 1 selected

Some aircraft have two installed, some only one

ATC FAIL Light—Indicates selected transponder (1 or 2) has failed



ACARS

Uses third transceiver

Printer Alert light may be reset by pressing one of two buttons:
Printer Alert Reset Light on ACARS printer
Printer light on SELCAL panel

Otherwise, similar to ACARS on other aircraft except:
No Takeoff Power Used reports need to be made
Engine Monitor Logs are automated
Closeout sent automatically with OUT event
See ACARS Quick-Reference Cards

PRINTER MESSAGE Light indicates a paper message has been delivered

PRINTER MESSAGE



Cabin Interphone Button

Connects oxygen mask microphone to Flight Attendant's cabin interphone system

Button is installed on communications panel

Electrical Systems

General

Three essentially identical 40 KVA Continuous output generators: One per engine; One on APU

Generators are never paralleled

DC power through 4 Transformer-rectifiers
- Any 1 of these can supply entire airplane load
- 2 Powered by Left AC Bus
- 1 Powered by Right AC bus
- 1 Powered by Ground Service Bus, which is normally powered by the Right Generator Bus

Automatic AC Crosstie connects the two AC Buses if only one is powered by an engine-driven generator unless a bus fault is detected

Manual Crosstie for DC system

Two 14V Batteries in series to provide 28V DC

Emergency Inverter
- Powers AC Emergency Bus by converting battery DC to AC if normal AC fails
- Same inverter powers refueling system when normal electrical power not available

AC Power

Generators



Constant speed drive maintains constant frequency output
- Can monitor CSD Oil Outlet temperature and temperature rise across the drive
- Monitor outlet temperature in flight—have to push and hold a button to check rise

Fault Protection
- Generator is removed from its bus and de-energized for "certain faults"
- Faults not listed in Flight Manual, and you can't fix them, so no list to learn!
- Fire handle trips respective generator control relay
- Can reset respective generator after fault has cleared (after fire handle reset, if applicable)

Priority for Power Selection in Automatic Switch Positions

Only the highest priority power will be taken, in the following order:
- ❶ Engine Generator
- ❷ APU
- ❸ External Power
- ❹ AC Bus Crosstie

Example: APU is powering all buses when left engine is started.
- When left engine comes up to speed and engine generator power is stable, APU generator will be replaced by the left engine generator in powering the left AC and (through TRs) left DC buses
- Shutdown of a generator automatically transfers its buses to the other operating generator through the **AC Crosstie Relay** (unless bus fault detected, then the bus remains unpowered.)

AC Crosstie relay

AC BUS X TIE OPEN / AUTO

Automatically connects one Generator to opposite bus if power source is disconnected

Two Exceptions:
- Bus Fault detected (i.e., short on the bus)
- Differential fault protection is activated

Protects operating generator from being damaged

Loss of L or R AC power activating AC Crosstie disconnects <u>Galley Power</u> *automatically*

APU will crosstie *in flight only*

External power *never* crossties

Power Distribution

<u>Normal</u>—Generator connected to its respective bus

<u>AC Crosstie</u> allows generator to power both sides

<u>Only one generator</u> can be selected for a given bus

<u>APU generator</u> can power either or both buses

Emergency AC Bus
- With the Emergency Power Transfer Relay unpowered, spring-loaded to the ***right*** side
- When connecting APU power—Left side first; check DC EMER BUS OFF light out
- Ensures power switches automatically to the ***left*** side when <u>only</u> the left side is powered
- Normal power source Left side when powered

<u>Ground service bus</u>—powered by APU or external power
- To be powered by External power, APU must be disconnected from the bus first; ***if not:***
- Indication—AC CROSSTIE LOCKOUT Light
- If lockout fails—GS bus powered by opposing sources, which can overload each other or the bus

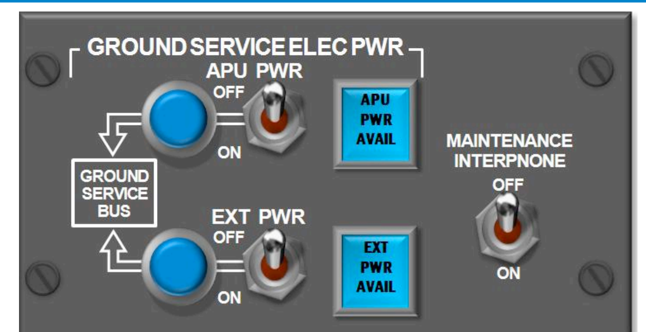
Power Available Lights

APU PWR AVAIL | EXT PWR AVAIL

Provided for APU and External Power—both indicate same for respective source

APU Power Available light *and*
External Power Available Light
- Power is available
- Power meets frequency/voltage requirements
- Phase sequence is correct
- However, ***NEVER*** a bad idea to check power before connecting to airplane

Ground Service Bus



Power for cabin lights, lavatories, etc., which are used to service the airplane at the gate

No power to avionics

Normal power source is from right AC distribution system with all buses powered

Can be powered from APU or **external power** without other airplane buses being powered

Key Operational items on **Ground Service Bus:**
- ♦Right Aft Boost Pump
- ♦Battery Charger
- ♦Center Instrument Flood Lights

DC Power

DC Bus Normal Power Sources

DC BUS X TIE CLOSE / OPEN

Left DC side is separated from right DC, similar to AC system

DC buses (L & R) are cross tied ***manually*** rather than automatically

Left side power
- Left TR 1 & TR 2 are powered by L AC bus
- TR 1 & TR 2 load share to power L DC bus

Right side Power
- TR 1 is powered from right AC Bus
- TR 2 is powered from the Ground Service Bus, which is normally powered by the right generator bus when all buses are powered
- Allows battery to be charged when ground service bus is the only bus being powered through external power on the ground

Emergency DC Bus

<u>Normal</u> power source:......................................Left DC bus
<u>Left DC Bus unpowered</u>:........................source is Right DC bus
<u>Both DC buses unpowered</u>:.............source is Battery Direct bus
(Power source then is the Battery)

EMER PWR OFF / ON

Emergency Power Selector

Connects Battery to Emergency AC & DC Buses

Disconnects normal power from these buses
- Fully-charged Battery should be good for 30 minutes with normal in-flight loads
- Normal battery load carrying these buses is 10-30 amps (up to 50 is allowed)

EMER PWR IN USE

White EMER POWER IN USE light confirms battery is powering these buses

DC Transfer Bus Off Light (Amber)

DC TRANSFER BUS OFF

Indicates no power to this bus

Should be off when battery is first turned on—indicates battery is powering DC Transfer Bus

After Generator and TRs are on line, the bus will be powered by these sources

Key items on DC Transfer Bus (SAFEE)

Standby Horizon

APU Door Control

Fire—Detection & Protection
- Agent Discharge Bottle Arming
- NOT Agent Low Lights
- Can't confirm bottle discharge with only Battery & EMERG buses powered

Engine Start Pump

Engine Ignition Override

Ni-Cad Battery & Battery Charger

BATTERY CHARGER

Battery Charger Light—Indicates battery charger failure

Pre-Flight Check
- During charging, amps read approximately 40
- Reading decreases as charging completes
- Reads 0 (*zero*) when fully charged
- Normal limits can be verified by:
  - Meter Selector to **BATT AMP**
    - Needle should be centered or to left, indicating charging
    - Needle should not be displaced right, indicating discharge
  - Meter selector to **BATT VOLT**
    - Verify voltage in normal limits of 29±4 Volts DC

Miscellaneous

Volt/Amp Indicator Selector

L or R positions
AC voltage & frequency for selected sources on respective meters

Other positions
Charge or discharge of current battery, battery voltage, or DC Bus voltage

BATT/VOLT Position: Bottom scale reads voltage

BATT/AMP Position: Top scale reads amperage

Needle displaced right indicates battery discharge

Needle displaced left indicates battery charging

Quick Reference for Which Buses are Powered

Captain's instruments	AC Emergency Bus
Captain's Pitot Heat	DC Emergency Bus
Standby Horizon	DC Transfer Bus

DC Bus Backup Power Sources

The outline on the following page is cumulative—it lists buses powered at each point in the sequence. All the buses above each level remain powered throughout the remainder of the sequence.



Battery OFF—
Battery Direct Bus

Battery Switch ON
Battery Bus
DC Transfer Bus

Emergency Power Selected
Emergency DC Bus
Emergency AC Bus, through Emergency Inverter

Other Warning Lights

APU Generator Off Light MC
APU is Operating and
APU Generator is not on line

L or R GEN OFF Light MC — L GEN OFF
Generator relay is open
L/R Gen disconnected from bus

BATTERY OFF light — BATTERY OFF
Indicates **BATT** switch is in **OFF** position

AC Crosstie Lockout Light — AC CROSSTIE LOCKOUT
AC Crosstie is locked open
Automatic crosstie inop

DC Bus Off Light MC — DC BUS OFF
L or R DC bus is unpowered
Or DC bus sensing circuit open

AC Bus Off Light (L or R) MC — L AC BUS OFF
Respective Bus is unpowered
Or AC bus sensing circuit open

CSD Oil Pressure Low (L or R) MC — L CSD OIL PRESS LOW
CSD Oil Pressure is below operating limits

Power Loss Chart

Condition: No Generators On Line; Battery Switch ON; Emergency Power Selector OFF

Buses Powered: DC Transfer Bus; Battery Bus; Battery Direct Bus (Powered even with **BATTERY** Switch **OFF**)

Capability: ♦Maintain Attitude ♦Fight Fires ♦Start Engines ♦Evacuate Passengers (All of these for 30 minutes)

Instruments & Radio	DC Transfer Bus
Standby Attitude Indicator	X
DC Start Pump	X
Override Ignition	X
Master Warning/Caution lights; Annunciator lights) MC MW	X
Oil Pressure Low Caution Lights	X
Fire Detection and Protection (no AGENT LOW lights)	X
APU Door Control	X
Generator Control	X
Pneumatic Airspeed & Altimeter	
Mag Compass	
N1 & N2 Indicators (Self-Generating)	

Lighting
Cockpit flood lights
Passenger cabin dome lights
Passenger emergency exit lights
Seat-mounted emergency escape path lighting

Condition: No Generators On Line; Battery Switch ON; Emergency Power Selector ON*

Buses Powered: Three Above Plus… Emergency DC Bus; Emergency AC Bus**

*Turns off Battery Charger
**Through Emergency Inverter

Capability: Navigate / Communicate / Penetrate / Shoot an ILS
Tell Passengers you are going to Evacuate Them

Still limited to the Battery life duration (30 Minutes)

Instruments & Radio

Captain's
♦Electric Altimeter ♦Attitude Indicator ♦Electric Airspeed Indicator ♦IVSI ♦HDI & Glide Slope

F/O's RMI and #1 Needle

Other Powered Items
♦#1 Navigation Radio (& ILS for Cat I approach—250' and ½ mile visibility)
♦#1 Comm ♦#1 Needle, not Card, on RMDI
♦GFMS ♦VG Switching Capability
♦EGT Gages ♦Intercom
♦Public Address ♦No Flight Director / Radio Altimeter / DME

Lighting
Cabin Standby Lights
Captain & F/O Variable Panel Background Lighting
If activated, the following are also lit with power from rechargeable battery packs for approximately 15 minutes:
♦Passenger aft stairway and tail section lighting
♦Exterior over wing emergency evacuation lights

Other
Air Conditioning Control in Manual; Pack Control (ON/OFF)
Cargo Smoke Detectors Loop B
Loop A is DC Transfer Bus
Loop B is Emergency DC Bus—See OM Volume 2, page FIRE PROTECTION-2)
Hydraulic Pumps revert to high output (no indication)
Manual pressurization
Flight spoilers will deploy to 60° manual limit
*No Ground Spoilers (Electrical operation)
*No flight directors or radio altimeters
*No Trim
*No flap indications, gear or slat lights
*Engine Anti-Ice remains as previously selected
*Wing Anti-Ice fails to OFF
*No Anti-Skid
*Cockpit door—Operative, but must be manually secured with deadbolt
*(Notes from ground school—not in OM)

QRH Tabs page 9.5-6

Engines

General



Engine Designation & Thrust

Pratt & Whitney JT8D

Engine	*Normal T/O Thrust*	*Max T/O Thrust*
-219	*21,000 lbs.*	*21,700 lbs.*

Oil System

Engine-driven main oil pump delivers oil to engine

L OIL STRAINER CLOGGING

OIL STRAINER CLOGGING Light **MC**
Excessive differential pressure at oil filter

L OIL PRESS LOW

L or **R OIL PRESS LOW** lights **MC**

Fuel System

Fuel Path to Engine:

♦**Engine-driven, first stage Centrifugal Pump**
♦**Air-Fuel Heat Exchanger**
13th Stage bleed air used to heat fuel

L FUEL HEAT ON

♦**Fuel Heat Switch controls**
Automatic 1-minute timer
L or **R FUEL HEAT ON** Light indicates system ON (*Blue*)
♦**Fuel Temperature Sensor**—Downstream of heater

L FUEL FILTER PRESS DROP

♦**Fuel Filter**
L or **R FUEL FILTER PRESS DROP** Light **MC**
Could be ice or contamination *but*
Ice is unlikely, especially when fuel temp is above 0°c
Bypass valve allows fuel to pass a clogged filter
♦**Fuel Flow Transmitter is between fuel control and fuel-oil heat exchanger**
♦**Fuel-Oil Heat Exchanger**
Cools oil, preheats fuel
Only reference—schematics, OM Vol. 2, ENGINES-20.3, 20.5

L ENG REVERSE THRUST

L ENG REVERSE UNLOCK

Thrust Reversers

Clamshell Doors can easily scrape on runway if deployed before nose wheel touchdown on landing
Two Status Lights:
ENG REVERSE THRUST Light—Associated reversers fully extended
ENG REVERSE UNLOCK—Associated Reverser unlatched

L REVERSER ACCUMULATOR LOW

One Warning Light
L (or R) Reverser Accumulator Low
Amber; no Master Caution Light

Starting & Ignition

Starting Power

High pressure air
Sources possible:
♦APU
♦External Air Cart
♦Opposite engine, using crossbleed*
***If used, need ≈36 psi, or N_2 80%** ....OM Vol I, START-15.8
Starter
♦Electrically controlled
♦Pneumatically activated

L START VALVE OPEN

L or **R START VALVE OPEN Light** for each engine on overhead panel indicates start valve butterfly is open

Ignition

2 Igniters per engine
Power Output:
High-energy System—20-Joule output
Low-Energy System—4-Joule output
Ignition Switch
OVRD—
High energy ignition to both igniters
No regard to position of start switches or fuel levers
CONTIN—
Low energy output to one igniter per engine
Fuel lever must be ON for respective engine

OFF SYS A SYS B BOTH OVRD

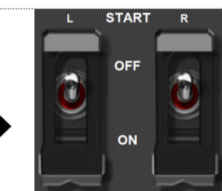
TWA A/C Ignition Switch
Has A and B systems
A or **B** Selected
If fuel control lever **ON**:
20-Joule AC ignition from respective (A or B) igniter
BOTH Selected
If fuel control lever **ON**:
20-Joule AC ignition from both (**A** and **B**) igniter
OVRD Selected
20-Joule AC ignition from both (**A** and **B**) igniter
Fuel control lever is bypassed .... **TWA**

Start Switch

FLT OFF GND

Three Position Switch
GND only—Start Valve opens if air pressure available
GND or **FLT**—
High energy ignition to both igniters
Fuel lever must be **ON**
No regard to position of ignition selector
Spring-loaded to **OFF**

TWA Aircraft Start Switch
OFF Removes power from engine start valve
ON Provides power to open start valve
No ignition function............. **TWA**



Automatic Reserve Thrust (ART) System

Basic design:

Automatic detection of engine failure during takeoff
Looks for one N_1 30% below the other (*See added notes p. 26*)
Thrust increased on operating engine at the fuel control
ART activates on max thrust takeoff with windshear encountered (OM Vol. II, p. WARNING & ALERT-50.4)

ART INOP

ART INOP Light on overhead panelART fault detected or system **OFF** with above conditions met

ART Self Test:

Initiated automatically when **(NAGS)**
N₁ *Signal—Both engines running*
A*uto position for ART switch*
G*round—Aircraft on the ground*
S*lats Not Retracted (Mid-sealed or fully extended)*

Self test complete—READY light (green) on—no faults detected, system operational

ART System Arming

READY
ART

Self test complete (**READY** light—see above)
Both engines above **64%**
System is then ARMED and looking for 30% N_1 difference
ART Light indicates when.................................
ENG-10.9, 20.8



♦Engine Failure has occurred (N_1 input) ***or***
♦DFGC switched (1-2) or failed ***and***
Reserve system has activated (results-see following)

ART System Actions when Triggered

ART solenoid shifts fuel control to a thrust schedule that increases EPR
Equates to approximately +.05 EPR
Operating engine instruments show increase in N_1, N_2, EPR, & Fuel Flow (No movement on throttles)
TRI updates to computed reserve thrust setting
Note: Thrust may increase above TRI-indicated setting. Do not retard throttle to match.

ART System Disarming After Takeoff

Before Slat Retraction
Both engines retarded below 58% N_1
READY Light remains ON
Re-arming occurs when power on both engines is advanced above 64%
After Slat Retraction—
Permanent disarm
Subsequent re-arm occurs after landing

ART Switch

AUTO—Automatic reserve thrust system enabled
OFF—ART system disabled



Automatic Thrust Restoration (ATR) System

Basic Design

Senses performance loss after takeoff
Assumes engine loss has occurred
Works through DFGC to unclamp throttles and increase power on working engine to Go-Around Power

Arming—TAP

T*akeoff*—Flight director in take-off (TAK OFF) mode
A*ltitude*—Radio Altitude over 350 feet
P*ower*—Both engines operating below Go-Around power
Note: *If engine failure occurs below 350 feet, ATR does not engage when altitude reaches 350 feet. (See added notes* *page 28*)

Activation

Vertical speed decrease to less than 0 fpm for five seconds *OR*
EPR drop ≥0.25 *and* N_1 loss ≥7% on the same engine

Actions Occurring when Activated

Throttles are unclamped (if ATs are engaged)
Both throttles advance equally until one of the engines reaches Go-Around EPR limit
If ART system is *armed* and ATR *activates*
ATR Target thrust limit is reduced by the amount the ART system is scheduled to provide
Prevents over-boosting with both systems attempting to augment thrust on same engine

Disarming

Occurs when any pitch mode selected on DFGC
Caution: *DFGC can incorrectly sense engine surge as engine failure.*
- Advancing throttle in this case worsens situation.
- Auto-Throttle limit requires disconnecting AT if surge or compressor stall occurs on T/O for this reason.

Other Systems

Approach Idle

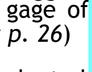
≈10% Higher than normal idle
Causes a slightly higher than normal idle to assist in the event of a go-around and need for engine spool-up (with or without engine failure)
Begins—5 Seconds after nose wheel indicates down
Ends—5 seconds after nose strut compression

Thrust Rating Indicator (TRI)

Interfaces: ♦RAT Probe ♦**Both DFGCs**
Reserve Thrust Selection
- ART Switch OFF
- TRI window—00° Selected
- T. O. Button depressed

Max Takeoff Thrust Selection
- ART Switch ON
- TRI window—00° Selected
- T. O. Button depressed

Uses RAT temperature to calculate max thrust
Engine failure detection by ART triggers display of Reserve Power on EPR gage of operating engine (*See added notes p. 26*)



Standard Power Takeoff Selection
- TRI Window—Assumed temperature selected
- **ART** Switch **OFF**
- **T. O. FLEX** Button depressed

Assumed temperature input used to calculate thrust

Takeoff Sequence
T. O. or T. O. FLEX buttons depressed
EPR bugs display EPR Limit as selected
After 50 knots A/S, computer stops recomputing EPR
At 60 knots autothrottle clamps if engaged

TRI Flight Modes & Indications

"Bottom Row" Buttons
- **CL**— Climb
- **MCT**—Max Continuous Thrust
- **CR**—Cruise

NO MODE Light indicates
EPR Limit mode is not selected *or*
Improper configuration for flight conditions (uncertified engine bleed configuration—see below)
- Airfoil AI **ON**; engine AI *not* **ON**; pneumatic crossfeed lever(s) in *any position*
- TO or TO FLX modes, engine AI ON, RAT>10 C
- GA mode, engine AI ON, RAT>14 C
  In other words, engine AI on >10°C ground/14°C flight
- MCT selected, airfoil AI ON, both X-Feeds OPEN
- CL selected, airfoil AI ON, and one pneumatic crossfeed lever CLOSED
- MCT, CL, or CR selected with packs off
- T. O. FLX selected, ART switch AUTO

In addition to light, EPR Lim flag appears

Engine Synchronizer System

Trims left engine to right engine
EPR is automatically synchronized with:
- Engine sync selector OFF
- Autothrottle engaged
- Any autothrottle mode except CLMP

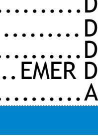
With Engine Sync Switch in N_1 or N_2
Matches N_1 or N_2 if they are within ±1%
ENG SYNC ON Light
Landing gear handle down
Engine Sync Switch in N_1 or N_2

System should *not* be on for
- Takeoff
- Thrust reverser operation
- Landing
- Airplane below 1500' AGL

Prevents problems, especially in the event of engine failure during a critical phase of flight

Engine Instrument Power Sources

AC Lies, DC Dies
AC-powered instruments freeze where they are
DC-powered instruments drop to zero
Categories:
All RPMs are Self-Generating (N_1, N_2)
All temperatures are—*DC* (EGT, Fuel, Oil)
All direct reading items—*DC* (temperatures oil quantity)
All pressures are *AC* (EPR, Oil)
All computed indications are *AC* (EPR, Fuel Flow)



Summary:	
EPR ....AC	Fuel Temperature........DC
N1 ....Self-Generating	Oil Temperature ....DC
N2 ....Self-Generating	Oil Quantity ....DC
Fuel Flow ....AC	EGT ....EMER DC
	Oil Pressure ....AC

Engine Display Panel (EDP)

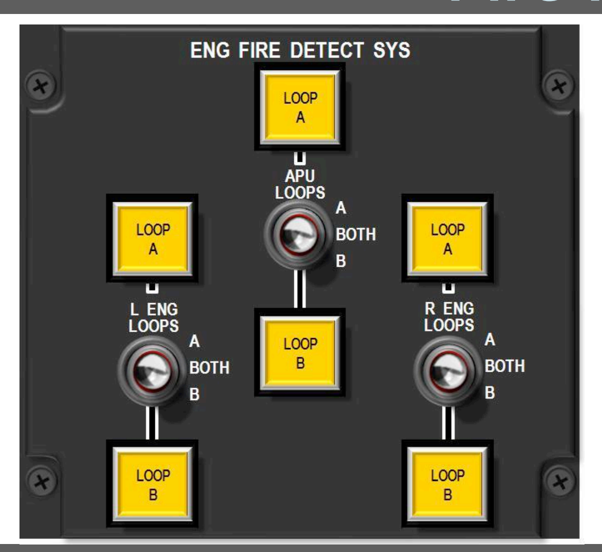
Engine data displayed on digital center screen
TWA 94xx and 96xx airplanes are affected
See TWA Supplement for details ....TWA



Throttle Response Failure

See “EPR Erratic or Fixed / Displays Dashes” procedure
QRH ENG-12

Fire Protection



Fire Detection Systems

Fire Loops—6 Total

Two Loops on each engine and the APU
Loops "A" and "B" for each of the 3 systems

Fire Loop Logic

Loop Switch in BOTH—
No fire warning unless both loops detect fire
Fire Warning Light in Both A & B Loops
Components activated when both loops detect fire
ENG FIRE light in engine fire handle, forward panel
Separate lights for **LOOP A** and **LOOP B**
Fire Detector Loop caution light
MASTER CAUTION Light MC
FIRE DETECTION LOOP caution light — FIRE DETECTOR LOOP
Fire Bell
Aural Warning: "*FIRE LEFT ENGINE*"
Pressing FIRE BELL OFF button
Silences Bell
Silences repeating aural warning
Fire detected in only one loop:
Loop light for respective loop
MASTER CAUTION Light MC
FIRE DETECTION LOOP caution light — FIRE DETECTOR LOOP
No aural warning

Loop Switch in A or B
Fire detected in that loop generates same result as above for both loops detect a fire with switch in BOTH

APU Fire Detection

All of the above details concerning engine fire loops apply to the APU *except*:

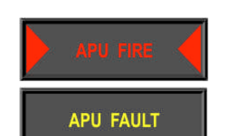
♦**Aural Warning is: ....**Alternating horn and "*APU FIRE*"
Repeated three times
Cannot be silenced

♦**External Horn**
Lower aft body, under left engine
Will not silence until the fire is out
Does not sound during test

♦**APU FIRE Light** MW

♦**APU Fire detected** arms external controls for fire bottles

♦APU Fault Light (See page 27 of this Guide for detail on this light)



Fire Protection Systems

Pulling/Turning Engine Fire Handles

Pulling Fire Handle—Five Actions result
2 Electrical effects
2 Fluid-related effects
1 Air-related effect

Turning Fire Handle—One Action Results
1 Fluid-related effect

Power Sources
Electrically activated actions from DC Transfer Bus
Mechanical actions are from a cable connection



Summary:

Pulling Fire Handle:

Power	Action	Category
Electrical	Aural Warnings Stops	Electrical
Electrical	Generator Control Relay Trips	Electrical
Cable	Fuel Shut off at Tank	Fluid
Cable	Hydraulic Pump Supply Shut Off	Fluid
Cable	Pneumatic Crossfeed Valve Closed	Air

Turning Fire Handles:

Cable	Fire Bottle Discharges	Fluid

APU Fire Protection

APU Fire switch to **OFF/AGENT ARM**
Shuts off Fuel to APU
Arms APU FIRE AGENT switches for discharge of bottles into APU
Generates overspeed signal to shutdown APU, bypassing 60-second timer
Trips APU Generator Relay (*Instructor note, not in OM*)

External APU SHUTOFF switch accomplishes the same actions as above

Agent Low Lights

AGENT 1 LOW
AGENT 2 LOW

Confirm Discharge
NOT Powered by any of the 5 battery-operated buses
If battery is only power source—lights inoperative

Lavatory Smoke Detectors

Purpose

Designed to detect and extinguish trash bin fire
May not detect smoking in lavatories

When Activated by Smoke Detection:

Cabin Lights Activated:
Associated Lavatory Call Light
Master Call Light
Lavatory Chime sounds at 1-2 second intervals
No integral alarm comes from the detector itself
Dissipation of smoke
Causes signals to stop
System resets automatically

Cargo Smoke Detection & Fire Suppression(SDFS)

Main Functions (When installed)

Detection of smoke in FWD, MID, and AFT compartments
Alerting of crew to presence of fire/smoke condition
Suppression of fire in one cargo compartment

Components

Cargo Fire Panel (overhead panel; replaces APU hr. meter)
CARGO FIRE light on overhead annunciator panel
Circuit breakers for loops A and B



Detection

Photo-electric cells and particle detectors in each cargo compartment
Each cargo department divided into several zones
Each zone has **two detectors** (one for Loop A, one for B)
Detection occurs when both detectors in a zone detect smoke
If one detector in a pair has a sensed fault, the remaining detector alone triggers detection if smoke is found
Smoke detection occurs "within 60 seconds"

Crew Alert

MASTER WARNING Light on glare shield
CARGO FIRE Light on overhead annunciator panel
Associated FWD, MID, or **AFT FIRE** Light/switch on Cargo Fire panel

TWA **Aural tone** sounds
Tone is silenced by momentarily pressing **ALARM OFF** button on cargo fire alarm panel

Suppression

Two halon fire bottles installed on right side of mid cargo compartment
Halon directed to proper compartment by diverter valves
First bottle—when compartment light/switch is pressed:
Discharged immediately, at high rate
BTL 1 LOW Light indicates bottle has been discharged
Second bottle
Discharged automatically after 15 minutes, at a slower rate
BTL 2 LOW Light indicates bottle has been discharged

Lights and Switches

FWD, MID and AFT FIRE Lights
ON—when:
◆Both detectors in the same zone detect smoke *OR*
◆One detector has faulted ***and*** the other detector in the same zone detects smoke
Pressing illuminated cargo compartment fire light discharges halon into compartment (see above)

FAULT Light—On when:
Test Switch pressed
SDFS Failure detected
If test is done with a valid fault present, light goes out after test and comes back on after 2-second delay



BTL 1 (or 2) LOW Light—On when:
Test Switch pressed
Bottle pressure low—should occur 10-20 seconds after illuminated fire switch is pressed (bottle 1) and shortly after the 15-minute delay (for bottle 2; see above)



BTL 1 (or 2) CHK Light—On when:
Test Switch pressed
Verifies continuity of respective squib

FWD, MID and AFT VALVE Lights On when:
Test Switch pressed
Verifies proper function of corresponding halon diverter squib

__Cautions__: ***Whenever squib lights are illuminated****, even during test, pressing a bottle discharge switchlight,(i.e.* **FWD FIRE***, etc) will discharge halon.*
Resetting **MASTER WARNING** *Lights during test will disable Cargo SDFS from illuminating* **MASTER WARNING** *Lights again. Pull and reset c-b on overhead c-b panel (A19 and A20), if required.*

TWA Cargo Smoke Detection & Fire Control



Detection—Similar to AA aircraft
A and B Loops selectable
A or **B** Position—enables only that loop
BOTH position is the normal mode
Arms both loops for smoke or high temperature detection

Protection
Exists in any cargo compartment
Cargo fire warning automatically arms number 1 fire bottle
BTL 1 Switchlight illuminates, indicating armed
To discharge, crew must raise guard and push **BTL 1** switchlight
Discharging bottle 1 arms the number 2 fire bottle
BTL 2 Switchlight illuminates, indicating armed
Bottle 2 discharges automatically after 15 minutes if still airborne

System is powered by DC Transfer Bus .... **TWA**

Additional Details—See:

FIRE Warning Test ....OM Vol. I, PRE-FLIGHT 10.20
TWA **Cargo Smoke Detection & Fire Suppression System (SDFS)** ....OM Vol. I, PRE-FLIGHT 10.20

Flight Controls

General

Primary Flight Controls
- Ailerons
- Elevators
- Rudder

Secondary Flight Controls
- Leading Edge Slats
- Trailing Edge Flaps (Inboard & Outboard)
- Flight and Ground Spoilers
- Horizontal Stabilizer

Most Primary Flight Controls are moved via cable-driven control tabs

Most Secondary Flight Controls are hydraulic

Primary Flight Controls

Lateral Control

Ailerons

Control wheels
- Connected to aileron control tabs via cables
- Control wheels are linked together by torque tubes
- Control Tab "flies" aileron to the necessary position

If part of the system jams:
- Either control wheel will drive unjammed portion and free control tab
- Approx. 50 pounds of force at wheel rim will push one side with other side jammed

Lateral Control Augmentation

Trim Tab
- Located on aileron trailing edge outboard of control tab
- Trim knob is cable-connected to trim tab

Flight Spoilers
- Deploy in proportion to aileron deflection
- Initial deployment is at 5° control wheel movement

Longitudinal Controls

Elevator Control—Via Control Tabs (Inboard)

Each control wheel is cable-connected to a control tab on its respective elevator

Only connection between control wheels (and therefore the two elevator sides) is a torque tube between the control stick on each side of the cockpit

If one control wheel cable breaks, either control wheel remains connected to the remaining elevator control tab

Elevator "Geared Tabs" (Middle)

Outboard of control tabs

Move to assist control tab movement

Geared to *elevator* movement

Elevator Anti-Float Tabs(Outboard)

Outboard of geared tabs

Geared to *Stabilizer* movement
- Trim motors reposition Stabilizers (See Below)
- Improves longitudinal trim in forward center of gravity (beyond 10° airplane nose up) landing configuration

Stabilizer Trim

Three methods of control input
- **LONG TRIM** Handles (Longitudinal trim)
  - Primary Trim motor
  - Fast trim
- Control wheel trim switches
  - Same primary trim motor as above
  - Fast trim
- **ALT LONG** Trim Control
  - Alternate trim motor
  - Slow trim

Priority is in the order above
- LONG TRIM Handles override input from yoke switches or alternate switch inputs
- Control wheel switches override ALT LONG trim switch inputs

Either motor drives a jackscrew, which repositions the stabilizer angle
- Primary trim motor—⅓° per second
- Alternate trim motor—⅒° per second

Each switch is a combination of two switches
- Motor Switch
- Stab trim brake release
- Neither switch alone can effect trim movement
- Any motor switch combined with any brake release switch will activate trim
- Opposite inputs from opposite yokes at the same time cancel each other

Autopilot uses Alternate Trim Motor

Double generator failure—no trim is available

Trim Aural Warnings

Warning horn sounds for one second
- Sound starts after ½ to 1 degree (approx.) of movement of trim by any of the trim motors
- Tone then repeats every ½ degree of motion

Stabilizer moved by the autopilot > 2° in 30 seconds results in *Aural Warning*: ...."***STABILIZER MOTION***"

(OM Vol. 2, p. WARNING & ALERT 10.15 and FLT-C 20.8)

Trim Motor Overheat Protection

Large motor on primary trim inputs

Too many rapid, short inputs or a few long ones will overheat motor

Motor cuts itself out when it overheats

Reset occurs when the motor cools

STABILIZER TRIM
STOP
NORM

Stabilizer Trim Stop Switch

Stops primary trim motor

Applies stab trim brake

Engine Strakes

Enhance post-stall recovery longitudinal control

Unheated

Elevator Augmentation

Designed to assist in stall recovery

Activation
- Elevator control tabs displaced 10° nose down with respect to the elevator
- Idea—Input must have been applied rapidly, or elevator would have flown to a new position

3000 psi. Hydraulic accumulator
- Charged by left hydraulic system
- Allows significant assist, even when hydraulic pumps are switched to low output

ELEVATOR POWER ON Light

ELEVATOR PWR ON

- Indicates hydraulic pressure has been used to assist elevator movement
- Checked on flight control checks

Mach Trim Compensator

Trim spring on F/O's yoke
- Indicator rod on F/O yoke deploys as system engages
- Gives visual verification of system activation

Engages at high mach (above .80 mach)

Pulls yoke aft as mach increases to compensate for airplane's mach tuck at these speeds

Can be overridden with switch on overhead panel

Mach Trim Compensator Indicator Placard
- Indicates direction of movement only
- Can't be used to verify position of compensator

Mach Trim Compensator Inop Light

MACH TRIM INOP

- Compensator monitor has deactivated the system *or*
- Mach Trim Comp switch is in **OVRD** position

Yaw Control

Rudder System—Powered Operation

Normal mode of operation is powered

Control tab is hydraulically locked flush with rudder surface

Trim Activation
- Trim knob on control pedestal
- Cable-Connected to actuator to bias the entire rudder surface to either side

Rudder System—Unpowered Operation

Activation—one of two ways:
- Rudder Hydraulic Control handle—**MAN**
- Hydraulic pressure 950 psi. or less

Either activation
- Unlocks control tab to fly the rudder (Normally locked in powered mode)
- Rudder pedals move rudder control tab
- Trim is still available via trim knob
- Restriction with manual control—Minimum speed 135 knots or approach speed until landing assured

RUDDER CONTROL MANUAL

RUDDER CONTROL MANUAL Light—Indicates no hydraulic pressure at rudder actuator

<u>Note</u>: *During engine out go around, may require up to 8° of bank in direction of good engine to maintain constant heading at go around speed of V_{REF} + 5 knots minimum or 135 knots, whichever is higher. ....QRH, FLT-C 16*

Trim is available by cable
- Connected to rudder control tab
- Makes a new neutral position

Nose Strakes

Assist directional control in high AOA flight
Heated by airfoil anti-ice system

Rudder Throw Limiter

Protects empennage from damage with excessive rudder use
Rudder Limiter pitot probe on vertical stabilizer senses speed for input to system

RUDDER TRAVEL UNRESTRICTED

RUDDER TRAVEL UNRESTRICTED Light
- Indicates full rudder authority is available
- Approach—must be on by 144 knots (MD-82) or 165 knots (MD-83)
  - If not, restrictions include:
    - ♦Minimum speed 135 knots or approach speed until landing assured
    - ♦12 Knots crosswind maximum allowable
    - ♦During engine out go around—up to ≈ 8° of bank in the direction of the good engine may be required to maintain constant heading at V2 speed or 135 knots, whichever is higher
- Takeoff—Must be *out* by 180 knots (MD-82) or 200 Knots (MD-83) ....*See abnormals, QRH, FLC C-16*

Protection is proportional
- 22° Rudder displacement maximum
  - Available at approx. 180 knots
  - Rudder Travel Unrestricted-indicates this situation
- ≈2½° Available at ≈300K

Light activation indicates full travel (22°) is available

<u>Rudder Limiter Lock</u>: Occurs with full rudder travel from any combination of trim and pedal inputs ***if***:
- Rudder Travel Unrestricted Light not yet on
- Rudder travel is then limited to number of degrees travel when limiter lock was engaged
- Normal operation (rudder limiter adjusting for speed conditions) can be re-established by momentarily:
  - Centering rudder pedals ***and*** centering rudder trim

Yaw Damper

YAW DAMP / OFF / ON / OVRD

Damps lateral oscillation
Activated when:
- Yaw Damper switch is **ON** —*or*—
- Yaw damper switch is **OFF** but AP is Engaged

Deactivated when switch is in **OVRD**
Rudder movements generated by the Yaw Damper are *<u>not transmitted</u>* to rudder pedals

YAW DAMP OFF

YAW DAMP OFF Light
- Yaw Damper is not operating
- Yaw Damper switch is **OFF** or **OVRD**





General

Inboard & outboard flight spoilers
- Operational at all times—In flight & on the ground
- Inboard flight spoilers—Left hydraulic system
- Outboard flight spoilers—Right hydraulic system

Ground spoilers
- Power from both L & R hydraulic systems
- Deactivated in flight
  - Inboard-most spoiler panels
  - Turbulence would disrupt engine intake airflow

Flight Spoilers

Supplement ailerons for lateral control
5° or more control wheel input—proportional spoiler deployment on downward wing

SPOILER DEPLOYED

SPOILER DEPLOYED Light
- <u>Ground</u>— Indicates spoiler lever full forward and any spoiler not stowed
  - Inhibited with TO power set
- <u>In Flight</u>—Either ***ground*** spoiler extended

Auto Spoiler Do Not Use Light

AUTO SPOILER DO NOT USE

Malfunction detected in ground spoiler ***or***
System armed, only one main gear senses ground contact
Does not preclude use of manual spoilers

Spoiler Aural Warning—On the Ground

♦**Spoiler lever** not full forward
♦**Either throttle** advanced
Horn and warning ....***"SPOILER"***

Speed Brakes

Four flight spoiler panels move symmetrically
Max panel deflection is 35° from flush

Speed Brake Aural Warning—In Flight

♦**Flaps extended** beyond 6°
♦**Speed brake handle** not full forward
Horn and warning.......................................***"SPEED BRAKE"***

Spoiler/Flap Extended MC

SPOILER / FLAP EXTENDED

Same conditions as above for Speed Brake Aural Warning Horn
De-energized in ground mode after landing with automatic spoilers armed until after retraction of flaps or speedbrakes

Ground Spoilers

Operate during landings and rejected takeoffs
Ground spoilers (Innermost panels each wing)
Flight spoiler panels (outer 2 panels each wing)
All 6 deployed 60° from flush

Auto Spoiler Operations on Takeoff

<u>Arming</u>—Squeeze lever; raise to armed position
<u>Activation</u>—Reverser thrust selected; Results:
- Spoiler lever automatically extends ground spoilers fully (All panels, flight and ground, move 60°, see above)
- Spoiler handle out of full forward activates auto-brakes after "short delay"
  - Delay defined as 1 second in **MAX** position, and
  - Approx. 3 seconds in **MIN** or **MED** ....LAND 20.6
- Manual spoiler deployment also signals brakes

<u>RTO Above 70 Knots</u>—Max autobraking applied to full stop or pilot takeover
- Uses pressure from both hydraulic systems
- OM refers to this as "dual system braking"
- (See also Vol. II, LANDING GEAR-20.5)

<u>RTO Below 70 Knots</u>—Minimum autobraking applied to full stop or pilot takeover
- Uses single (right) hydraulic system (*Not in OM—from study tape*)

Auto Spoiler Operation on Landing

<u>Arming</u>: Spoiler lever raised
- <u>Note</u>: Do not arm spoilers prior to gear extension (OM Vol. 1, LIM-10.19)

Activation:
- Main Wheel spin up ***OR*** Nose Strut Compression—Flight spoilers deploy 60°
- Above plus both throttles at idle and weight on main gear—Ground spoilers also deploy 60°
- For either of the above,
  - ♦Spoiler lever is moved full aft
  - ♦Autobrakes activate if armed

Reversal of Activation
- ***Left*** Throttle forward for go-around after spoiler deployment
  - ♦Spoiler Lever Retracts
  - ♦Autobrakes released

<u>Warning</u>: *If hydroplaning, auto spoiler deployment will not occur until ground shift at nose gear touchdown, but manual spoiler operation available at main wheel touchdown.* OM Vol. 2, FLT-C-10.9

Auto Spoilers—TWA Aircraft......TWA Supplement 45.1
No autobrakes
Auto spoilers not available on takeoff
Autospoilers may be armed for landing................. 

Flaps

Power Source—Both L & R Hydraulic systems

Dual actuators for each flap panel
Loss of either system—normal operations from the remaining system at a reduced rate

Flap Position Indicator

Dual needles for L & R flap
Separate transmitter on each outboard flap panel

Leading Edge Slats

General

Six separate panels on each wing
Mechanically connected to operate as a unit
Power from both L & R Hydraulic systems
Loss of either system—normal operations from the remaining system at a reduced rate
Airfoil Anti-Ice Protection provided

Slat Positions

Retracted
Mid-Sealed—Middle position, with trailing edge of slat panels still in contact with the wing leading edge
Selection—Flap handle between 0/EXT and 13/EXT
Movement of Slat—Hydraulic
Fully Extended—Slat full down/forward with panels separated from wing leading edge
Selection—Flap/slat handle at or beyond 15/EXT
Movement of Slat—Hydraulic/electrical by stall warning computers when handle moved beyond 15°

Autoslats

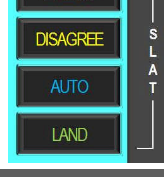
Provide positive stall prevention with flaps down
Activated through the stall protection system (*see below*)
Arming:
Speed below 240 knots
Flap/Slat Handle in 0 to 13 T/O (EXT) range
Either of the two stall-warning computers detect approach to stall
Ground Self-Test
- ♦Takeoff Flaps (0-13) set
- ♦Slats extend from retracted to mid-sealed
- ♦Stall computers generate a signal to drive slats to Extend position
- ♦While slats extend beyond mid-sealed, DISAGREE and AUTO lights illuminate
- ♦Slats return to mid-sealed position
- ♦Slat TAKEOFF Light comes on

Invalid test indication:
Auto Slat Fail Light on **MC**
May be reset & test repeated



Indicator Lights

TAKEOFF—Flap/Slat handle in T/O range
DISAGREE—L and/or R wing slats disagree with each other and/or Flap Slat handle position
AUTO—Slats have been automatically extended from mid to extended by the stall warning system
LAND—Flap/Slat handle set at more than 26° and slats fully extended



Other Systems

Stall Protection System

Stall protection
Provided from two independent electronic stall detection and indicating systems
Inputs to each system
- ♦Angle of attack vanes
- ♦Horizontal stabilizer position transmitter
- ♦Flap / slat position transmitter

Either system provides three warnings and/or actions before fourth and actual "*STALL*" audible warning occurs

Stick pusher
Fifth and final event
Occurs only if:
- ♦Both stall warning systems operational
- ♦Both systems sense a stall condition
- ♦Slats have been fully extended

Sequence of FIVE warning/activation: (**S**peed **ASAP**)
Speed *Low* ....**SPD LOW** displayed on FMA pitch window
Autoslats......................Slats to full extend if mid-sealed
Stick Shaker ....Activates approaching stall
Aural warning ....Audible **"STALL"** & klaxon at stall speed; **STALL** lights illuminate
Pusher ....Activates if both systems sense stall **AND** slats fully extended

Stall Warning
System provides stall ***warning*** with flaps/slats retracted
Either stall warning computer can sense stall and signal stall ***warning***

STALL

Stall Prevention
System provides positive stall ***prevention*** with flap/slat handle set in the 0/EXT to 13° range
One stall warning computer sensing conditions approaching a stall activates stall ***prevention*** (Slat DISAGREE and AUTO lights ON)
Both stall warning computers must sense stall to initiate ***Recovery*** (Stick Pusher)

Stick Pusher Activation results in:
- ♦Autopilot disengages if on
- ♦Stabilizer input is made to reduce G-force
- ♦Stick pusher push to inhibit Lights illuminate

Stick Pusher Deactivation
- ♦Stick shaker shuts off
- ♦Airplane experiences a reduction in G-Force
- ♦Accomplished by pushing either **STICK PUSHER PUSH TO INHIBIT** Light
- ♦May be overcome by physically pulling stick back



STALL FAILURE INDICATION

Stall Indication Failure Light
- ♦System Failure sensed ***or***
- ♦Disagreement between system 1 and 2 ***or***
- ♦Post stall pusher system is shut off by pressing either **STICK PUSHER PUSH TO INHIBIT** light or by "G-Switch" (reduction of G-forces)

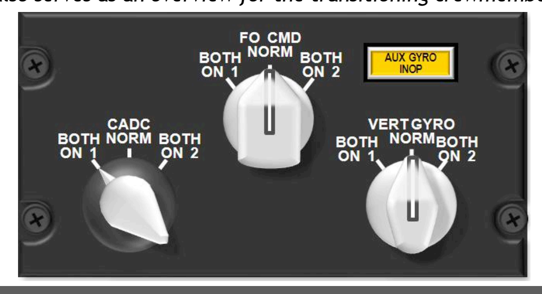
Takeoff Warning

7 Items—Associate with items on Control Pedestal
Stab Trim Handle—1 item
Stab trim not within ± 1 unit of the setting in the Long Trim Window
Aural Warning ....**"STABILIZER"**
Spoiler Handle—2 Functions, 2 Warnings
Spoiler lever not full forward
Aural Warning ....**"SPOILER"**
Auto-spoiler not armed with auto brakes armed
Aural Warning:................................**"AUTO SPOILER"**
Flap/Slat Handle—2 Functions, 2 Warnings
Flap Position not in agreement with Dialed Flap setting in window
Aural Warning ....**"FULAP"**
Slats not extended (either mid-sealed or fully extended)
Aural Warning ....**"SLATS"**
Auto-Brake Panel—2 Switches, 2 Warnings
Parking Brake Set
Aural Warning ....**"BRAKES"**
Auto-Brakes not Armed with Auto Spoilers Armed
Aural Warning ....**"AUTO BRAKES"**

Alternate memory jogger: SAAB FSS
S*tab Trim not Set for Takeoff*
A*uto Brakes not Armed*
A*uto-Spoilers not Armed*
B*rakes*
F*laps not Set for Takeoff*
S*lats not Extended*
S*poiler Lever not fully Retracted*

Flight Instruments

__Note__: No attempt has been made here to completely describe the flight instrumentation displays and their connection to the FMS. These subjects are best learned using computer-aided color presentations, and are used on a day-to day basis by flight crews. Instead, key systems-related subjects have been summarized, which are easily forgotten and little used except for orals and recurrent training, and, of course, in the event of an actual malfunction. This section also serves as an overview for the transitioning crewmember.



Primary Instruments

Primary Flight Instrument Categorization

Primary flight instruments
- ♦Mach/Airspeed Indicators
- ♦Altimeters
- ♦Vertical Speed / Resolution Advisory Instrument
- ♦ Attitude Indicators..................OM Vol. II, FLT-I 20.1-20.5

CADC Normal Operations

Sources for primary flight instrument information
CA From CADC 1
FO From CADC 2
Standby Instruments (center)—Alternate system comprised of auxiliary pitot/alternate static inputs

Altimeter Reporting Data

Transponder altitude data is independent of DFGS panel
Altitude data transmitted is based on 29.92 reference regardless of the baro setting on any cockpit altimeter
ATC Applies correction to altitudes below FL180

Static Air

Static Air Source Switch
- Two possible sources for static *air*
- Can be used to select static source for CA and FO static instruments
- NORM—CADC Selector Switch selects static pressure source (see selector details following)
- ALT—Alternate pitot-static system selected
- May be selected on either side of the cockpit:

CADC Selector (Overhead panel)
- Three possible sources of Pitot-Static *information*
  - ♦CADC 1 (CA system sensors)
  - ♦CADC 2 (FO system sensors)
  - ♦Alternate System
- With switch in **NORM**
  - CA Side CADC is #1
  - FO Side CADC is #2
- CADC BOTH ON 1; or BOTH ON 2
  - Places both sides of the cockpit on one CADC
  - Adjustments to altimeter setting may only be done from the selected side
  - Opposite side altimeter set knob is inop

CADC Light
- CADC Selector is out of NORM *and*
- Switching has occurred

Standby Airspeed Indicator & Altimeter
- Data always from Alternate Pitot-Static System
- Source cannot be switched

FD Light—FD Cmd Selector is out of the NORM position.

Radio Altimeters

Incorporated into EFIS displays
Rising runway symbol
- Activated at 200 feet
- Meets Center of instrument at 0 Feet

No ON/OFF Switch
Displays automatically when A/C ≤2,500' AGL
DH is green, followed by set value— DH 807
At DH— DH..XXX **changes** to yellow DH without altitude
Yellow DH symbol flashes for three seconds, then steady

Standby Instruments

Standby Attitude Indicator

Powered by DC Transfer Bus
Orange flag at "2 o'clock"
- Indicates power lost to indicator
- Should continue operating for approximately 7 minutes

Standby Altimeter

Pressure Operated Digital Counter
Near Zero Hangup
- Tends to hang up slightly passing 12 O'clock
- At "Zero" readings, pressure must be sufficient to rotate the cog moving the thousand foot counter
- Hang should not exceed a 25 foot lag or jump
- If it does, E-6 write-up is required

Static source is alternate static system

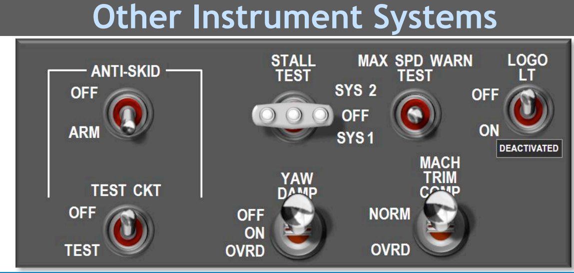
Standby Airspeed

Static source is alternate static system
Inputs are not corrected by a CADC

Standby Altimeter and Airspeed—TWA Aircraft

The two instruments are combined into one
See TWA Supplement....................OM Vol. II, p. 50.4 TWA

Other Instrument Systems



Overspeed Warning System—MAX SPD WARN TEST

Dual System—1 & 2
- Both are tested on origination pre-flight
- System 1 Test—tests Captain's system
- System 2 Test—tests First Officer's system
- Aircraft Overspeed detection results in Clacker plus
- Aural Warning: ....*"OVERSPEED"*

Slat Overspeed
- Occurs if Slats not retracted at 280+ knots
- Aural Warning:................................*"SLAT OVERSPEED"*

Standby Magnetic Compass

Located above F/O seat
Designed to be out of the magnetic interference from electrical items in the forward panel area
Viewed with mirrors from pilot's stations

Instrument Error Tolerances

Specified for Primary & Standby Altimeter, Mach/AS, VVI, and Standby Attitude Indicator ....See OM Vol. 1 SYSTEMS-55.2

Attitude Indication Source

Vertical Gyros—4
#1-Captain, CB location F-15
#2-First Officer, CB location...F-2
Auxiliary, CB location..F-1
Standby ADI has dedicated gryo ....CB locationX-31
See CB diagrams, OM Volume II, ELECT-10.14, 10.17

Flight Management

This section contains only selected notes specific to the MD-80. Many aspects of navigation are common to other aircraft with which pilots will be familiar.

Performance Management System



Fully integrated, selectable mode of the Digital Flight Guidance System (DFGS)

Computes a cost efficient flight profile based on
- Cost index value
  - A number from 0-255
  - Represents the relationship between fuel costs and the fixed costs of time related items
  - The lower the cost index. the more biased the computer is towards fuel savings
- Airplane performance, and
- Manual inputs.

Altitudes below 10,000 MSL—
- Automatic speed restriction of 250 knots applies
- Can be manually overridden

The PMS computed profile
- Includes a top of descent (TOD) point for idle thrust descent to bottom of descent (BOD
- Uses existing vertical speed and altitude (compared to the armed altitude) to determine its operating mode (CLB, CRZ, or DES).
- Each of these modes can be operated in
  - optimum (OPT) submode for minimum operating cost or
  - Non-optimum (NON-OPT) submode which uses a manually entered speed and / or rate of climb or descent.

Initial entry to the CLB, CRZ, or DES mode—
- PMS selects the submode (OPT or NON-OPT) which has been armed or selected
- If no submode armed or selected, the PMS automatically selects the optimum (OPT) mode for CLB and CRZ, and the non-optimum (NON-OPT) mode for decent.

Index is a factor of time vs. fuel prioritization
- If time is more important than fuel savings, cost index is higher
- If fuel savings are more important than time, cost index is lower

Performance Management System Lights on Pilot's Panels

CDU MESSAGE—Alerts to a message in the scratch pad area

VERTICAL ALERT Light—
- 15 Seconds to a PMS-generated vertical leg change (vertical waypoint)
- Comes on only when PERF mode is engaged
- Goes off when vertical leg change is completed or when CLEAR button is pressed

Multifunction Control Display Unit (MCDU)



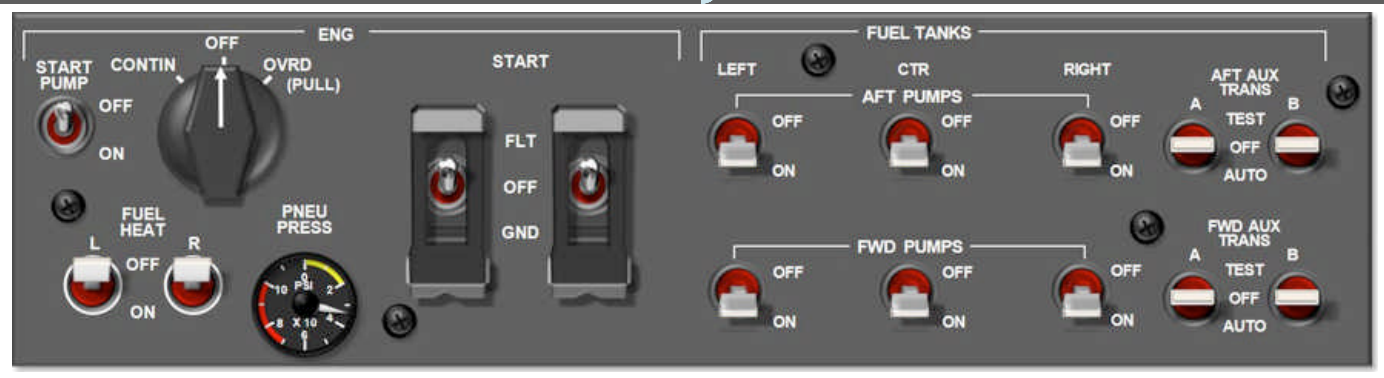
Screen Format

Top line
- Title on left
- <Page number> / <of total on right>

Left & right sides
- Line-Select Key selectable fields
- Data can be selected to scratchpad, or inserted from scratchpad to the route information areas

Bottom line
- System generated messages
- Keyboard entries
- Data being moved to display field (scratchpad)

Fuel System



General

Fuel Tank Configuration

All aircraft—3 Tanks
- 1 Center Tank in Fuselage
  - Capacity ≈ 20,600 lbs.; no suction feed capability
- 2 Wing Tanks (Left Main and Right Main)
  - Capacity ≈ 9300 lbs.; suction feed capability

-83 Aircraft Only
- 2 Aux Tanks, 3785 Pounds Each

Total Fuel Capacity	Amount
Center Tank	20,596
Main Tanks (2x9,266)	18,532
Total, -82 Airplanes	39,128
Aux Tanks (2x3,785)	7,570
Total, -83 Airplanes	46,698

Fuel Feed & System Operations

Main Tank Boost Pumps

Each Tank has 2 boost pumps
- -82 Airplanes have six total
- -83 Aircraft have ten total

All 6 (or 10) pumps are identical in output pressure

Any one of the 6 (not aux) can supply both engines at takeoff power

Center Tank Pumps
- Connected to each other in series
- Allows center tank to feed fuel at a higher pressure, therefore before wing tanks if all boost pumps are operating
- If one center tank pump fails—
  - Wing tanks tend to feed first
  - Center tanks have farther to pump fuel & more baffles, etc.

Fuel Transfer to Wing Tanks
- With center tank pumps on and wing tanks not full, fuel may transfer to wing tanks
- Maximum transfer rate—200 pounds per hour

Fuel Crossfeed Lever

Crossfeed OFF—Left wing tank feeds left engine and vice versa

Crossfeed ON—Allows left boost pumps to pump fuel to both left & right engine, and vice versa

Aux Tank Boost Pumps

Separate switches for each (Left & Right) pump in Forward and Aft Aux Tanks

4 Switches total

Aux Tank Fuel Transfer (Some Aircraft)
- **AUTO**—Arms AC circuit to power applicable transfer pumps
- Fuel transfer starts when center tank reaches approximately 13,000 lbs.
  - <u>Note</u>: Ensure fuel begins transferring by approximately 12,500 pounds center tank fuel

Total fuel center tank	20,596
Max center fuel used before transfer	-8,500
Difference	12,096

See OM Vol. I, LIM-10.24

Aux Fuel Pump Pressure Low (Fwd/Aft)

AFT AUX FUEL PRESS LOW

Comes on when pump is on but no fuel is being transferred

DC Start Pump

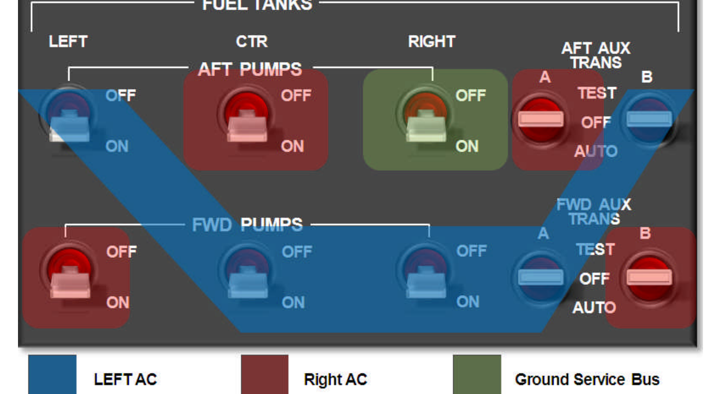
In Right Main tank

Used for APU starting when only battery power available

Powered by DC Transfer Bus

Power Sources

Sometimes referred to as "Lazy L" or "Lazy U"
- ......For Main Tanks (All tanks on -82s)
- ......For Aux Tanks included (-83s Only)



***-83 Airplanes Only**

****If powered,** ground service bus may be used for right aft boost pump to supply APU instead of DC start pump; (Dashed line is not on fuel panel)

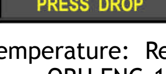
Fuel Heat

FUEL HEAT L R OFF ON

Uses 13th Stage bleed air to heat fuel entering fuel filter

Use is for:
- ♦Fuel temperature 0°C or below
  - Initiate on one engine, wait until engine parameters stable before starting other engine fuel heat
  - Momentary selection activates timer
  - Leave **ON** until a rise in fuel temperature and engine stable before selecting other engine

    L FUEL HEAT ON
  - One cycle no later than 1 minute prior to T/O or approach OM Vol. 1, SYS-65.1
- ♦**FUEL FILTER PRESS DROP** Light ON **MC**
  - Blockage at filter is occurring



When Fuel heat is on, check
- Fuel Temperature rise
- Oil Temperature rise but below limiting temperature: Red Radial Line ....QRH ENG-16

Fuel temperature should be monitored for a drop when **FUEL HEAT ON** light extinguishes
Must be **OFF** for takeoff, approach, landing and go-around

Fuel Inlet Low Pressure Sensor
Indicates lower than optimal pressure at respective engine fuel pump
Normally indicates boost pump failure
Lights Illuminated:
L (or **R**) **INLET PRESS LOW**
MASTER CAUTION Light **MC**

L INLET FUEL PRESS LOW

See Vol. I Systems-65.1 for additional system operating considerations and parameters.

AUTO Position (Some TWA Aircraft)

Initiates 1 minute fuel heat cycle if
♦Fuel filter clogging is sensed ***and***
♦In flight
If clog is still present after first cycle, a second minute is automatically generated
Procedurally, this switch is not used
See OM Vol. II, TWA Supp page 35.2 **TWA**

Fuel Loads

STD Load:
All fuel in wing tanks
If more fuel required than wing tanks can hold, remainder in center tank
After center tank full, Aux tanks fueled

***TO5 Fuel Load**
Used to hold nose gear down when towing or taxiing the airplane for maintenance purposes with insufficient fuel load for proper balance
5000 pounds in Center Tank
Remainder of required fuel in wing tanks (not necessarily full wing tanks)

010 Fuel Load
Fuel in center tank in hundreds of pounds, when wing tanks are not full
Range is 010-200 for 1,000-20,000 pounds
Example: 050 = 5,000 pounds
Remainder of fuel is in wing tanks
When used, max ZFW will be reduced by the amount of fuel in the center tank.

***ALT Fuel Load**
10,500 pounds of fuel divided between wing tanks
Remainder of required load in center tank
Used for Light passenger loads or ferry flights

SLP Fuel Load
Each wing is filled to 300lbs less than full due to steep ramp slope
Prevents fuel spillage

NAX—No aux tank fuel due to MEL restriction
NCF—Center tank empty or unusable due to MEL restriction

***NOTE:** *When fuel is in the Center or Aux tanks, and the Wing tanks are not full, the total of (actual zero fuel weight + Center tank + Auxiliary tank fuel) must be <122,000 pounds. See OM Vol. 1, p. LIMITATIONS 10.24, and Performance Manual LOADING p. 30.1*

Ballast Fuel procedures............OM, Vol. I, LIMITATIONS 10.24 ***and*** Performance Manual LOADING 30.1

Center Fuel Pressure Low

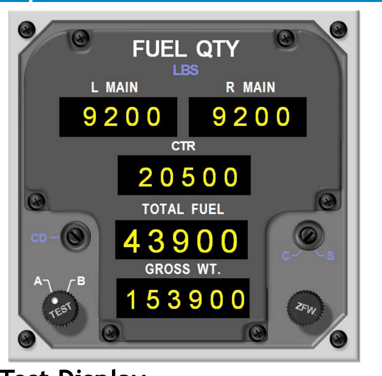
Low fuel pressure sensed in center tank with pumps on
Delay prevents false warnings from fuel sloshing........ **TWA**

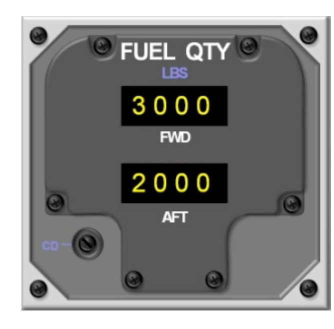
Fuel Use

Feed Center tank fuel is used first
If Fuel in Aux tank, feed:
Center tank down to approximately 13,000 pounds remaining (but not below 12,000, see note on previous page and in the Limitations—Fuel section concerning no more than 8500 pounds used from center tank)
Then feed aux tank fuel into center tank
Then feed remaining center tank fuel
Than feed wing tanks, keeping them balanced

Fuel Quantity Displays

Separate Indicators for Each Tank





Test Display
Each Tank reads 3000 +100 Pounds
Total is 9000 +300
With Aux Tank, Total is 15,000 +500
Gross Weight reads ZFW + Fuel

Aux Tank displays on Captain's Panel (Right, above)

Fault Displays
88888 = Normal Test display
Blank = Circuit Fault
Can Try alternate circuit (A vs. B)
99999 = Tank Fault at Probe
With bad probe, no alternate means to try
Dashes (- - - -) = component failure .... **TWA**

Fuel Pounds Used Counters



Digital counters in each fuel flow indicator
Estimates fuel used based on fuel flow and time
Reset on pre-flights

Additional Fuel Notes

If a go-around is required with less than **1000 pounds of fuel** in either wing tank, avoid excessive or sustained nose up attitude in excess of 10°

Go around is not recommended with less than 500 pounds of fuel in each main tank. ....QRH FUEL 12.1

Hydraulics



General

Two independent systems

Each system consists of:

- Engine-driven hydraulic pump
- Reservoir
- Ground servicing point in respective wheel well

Electrically operated auxiliary pump supplements right system

Power transfer unit takes pressure from either system to power remaining system if it still has fluid

Reservoirs

In Main Gear Wells

Temperature sensor lights

- L (or R) HYD TEMP HIGH **MC**



- Activates at ≈200°F

Ram air is routed through each wheel well to cool reservoir and lines

Fluid quantity transmitter in each reservoir

- Quantity should be read with system pressurized
- Otherwise, air in the system can lead to false reading off-scale high
- If this indication is seen, make E-6 write-up

Engine-Driven Pumps

Selectable output

- 3000 psi.—HIGH—Upper Green Band
- ≈1500 psi.—LOW—Lower Green Band

Pressure sensor for warning lights

- L (or R) Hyd Press Low Light **MC**

L HYD PRESS LOW

- Activates at ≈900-1200 psi.
- Downstream of pressure gage sensors, so good gage pressure possible simultaneous with a warning light
- __Note__: May indicate the respective spoiler depressurization valve is closed (Instructor notes).

Auxiliary Pump

Electrically powered

Designed for continuous output at 3000 psi

Temperature protection—shuts down if overheat sensed

OVRD Switch position bypasses heat protection if output needed

Hydraulic Control Panel—TWA Aircraft

Pump switches labeled differently from AA aircraft

Switches are "functionally equivalent" .... **TWA**

Power Transfer Unit

Mechanically connects left & right sides

- Pressure is transferred from high side to low side
- High side acts as power source
- Low side acts as a pump

Unit control—single motor operating two shutoff valves

- Shutoff valve closes automatically if either system reservoir drops below a safe level

Unit located in Left main gear wheel well

Powered by Left System (LIE)

Left Thrust Reverser
Inboard Flight Spoilers
Elevator Boost

Powered by Right System (GRROS)

Gear
Right Thrust Reverser
Rudder
Outboard Spoilers
Stairs

Powered by Both Systems

Associate with key systems for ground stopping & directional control

- ◆**Flaps & Slats** (allows slower landing speed)
- ◆**Brakes**
- ◆**Nose wheel steering**
- ◆**Ground Spoilers**

__**Note**__: *Systems operate at reduced rate if one pump is powering systems on both sides (one pump inop)*

Backup Accumulators Provided for: (BEARR):

Brakes...2
Elevator Boost...1
Aft Stairs..1
Rudder (Shared with Aft Stairs)......................0
Reversers..2
Six Total...6

Items which assist with stopping the aircraft have two accumulators, one on each side. (Brakes & Reversers)

Electrical Power Failure

Engine-Driven pumps fail to the high output mode if the L & R DC buses are unpowered

Power transfer unit shutoff valves remain in the position they were in at electrical power failure

Spoiler Depressurization Valve

Used for maintenance tests

One in each wheel well for respective side system

On preflight—should be checked **ON** (pressurized)

- Makes a **"T"** with incoming hydraulic lines
- Three-position valve; **ON** (normal, pressurized for flight) is the **"T"** position

Power Sources

Respective L/R AC............................Hydraulic pressure gage
....Hydraulic quantity Gage
....Brake pressure gage
Left AC......................Auxiliary pump for right hydraulic system
Right DC ....Power Transfer Unit control
....Right hydraulic pump control
Left DC.......................................Left hydraulic pump control

See OM Volume II, ELECTRICAL 13-19

ICE— Anti-Ice and Rain Protection



Anti-Ice

Anti-icing Definition

See Flight Manual Vol. 1, p. LIM 10.29 *or* *Page 12 of this Study Guide*.

Engine Heat

Each engine supplies its own heat
- No crossover capability
- Separate switches for each side

Ice protection for:
- Engine nose cowl
- Inlet bullet
- Compressor inlet guide vanes

Airfoil Anti-Ice

Engine bleed air feeds into common airfoil anti-ice duct
- Pneumatic crossfeeds open to allow air to airfoil
- Either engine can provide sufficient airflow

Heating air provided (in-flight only) for:
- Wing Leading Edge Slats
- Forward Strakes
- Air Conditioning Ram Air Scoop
- Horizontal Stabilizer Leading Edge
  - TAIL button diverts airfoil heating air from wing and forward strakes to horizontal stab
  - Remains diverted for 2½ minutes
  - Automatically reverts to normal mode
  - Can't stop 2½ minute timer once started
  - Use at three main times:
    - Every 20 minutes in icing conditions
    - One minute before extension of landing flaps
    - Prior to turning Airfoil Anti-Ice Off when icing conditions no longer encountered

Probe Heat—Electric

Heats the following:
- Pitot Tubes
- Static Port areas
- AOA Probes
- RAT Probe (Inhibited on ground)

Windshield Anti-Ice

Electric

Must be ON for all flight operations

For Limitations............ ...*See page 11 of this book*, *or* LIM 10.30

Overwing Heater System

OFF
O/W HTR Armed

Caution: (Summarized from OM)
- ♦..*Ice shedding from upper wing surface can severely damage engines*
- ♦..*Clear ice forming over cold fuel tanks is main cause*
- ♦..*Ice forms most often on the inboard aft corner of main wing tanks*

Heating blanket covers approx. 45 square feet of upper wing surface in front of engine inlets

Rough ice-detection stripes painted on top of the blanket

On ground, single engine taxi without APU—system is load-shed

Operation
- Ground only—deactivated in flight by ground shift
- Maintains heated surface from 40°F (4°C)-85°F (29°C)
- Inhibited by **O/W HTR** switch placement to **OFF**
- Completely automatic in normal use

Warm Light—Indicates both heaters ≥ 40°F (4°C)

L FAIL or **R FAIL** Lights—any detected fault

Load-Shedding
- Occurs automatically with O/W Heaters powered
- Items shed vary power source available
- Sole Power Source..........................Automatic Load Shed
- External *or* APU Only ....Galley 4
- Single Engine Generator....................All galleys, ***and both*** overwing heaters

OM Vol. I, SYSTEMS 35.1

Ice Detection Ring

Located on both L and R windshield wipers

Provides a representative surface to help determine whether ice may be forming on airplane surfaces

Warning Lights

Overwing Heater Warm/Fail Lights

L FAIL | R FAIL | WARM



Located on Captain's instrument panel

L (or **R**) **FAIL** Light
- Fault detected with power applied

WARM Light
- Indicates power is applied ***and***
- Temperature of both heaters is over 40°F (4°C)

Note: *WARM and FAIL lights are inhibited when throttles are advanced for takeoff.*

L or R Engine Anti-Ice On

L ENG ANTI-ICE ON

Indicates one or more engine anti-ice valves have fully opened

Note: *When any engine anti-ice valve is open, light will illuminate regardless of engine anti-ice switch position*

L or R Engine Valve Lights

L ENG VALVE

Indicates disagreement between switch position and any engine valve(s) on the affected engine

Ice Protect Supply Press High Light MC

ICE PROTECT SUPPLY PRESS HI

Excessive duct pressure (> 22 psi)

Malfunction of ice protection pressure regulating valve

Minimum duct pressure for anti-ice use—20 psi

Pitot/Stall Heater Off Light MC

PITOT STALL HEATER OFF

Meter selector in **OFF *or***

Meter in **ON:**
- Electric power loss to one or more of the pitot tube or stall warning indicators

Note: *Does NOT come on for static port heater.power failure*

Airfoil Ice Protection Press Abnormal Light MC

AIRFOIL ICE PROTECT PRESS ABNORMAL

Low or **unbalanced pressure** in wing and strakes ***or***
Low pressure in duct to horizontal stabilizer ***or***
With airfoil anti-ice switch in OFF—Malfunction of ice protection regulator

Note: If inadequate anti-icing available, add 10 knots to approach speed and use flaps 28° for landing. ....QRH ICE-1

Ice Protect Temperature Low

L ICE PROTECT TEMP LOW

Air temperature in pneumatic crossfeed too low for operation of anti-ice
May be due to:
- Low engine thrust ***OR***
- Closed pneumatic crossfeed valve(s) ***OR***
- Malfunction of the augmentation valve

Ice Protect Temp High MC

L ICE PROTECT TEMP HIGH

Air in pneumatic crossfeed is above normal operating temperature
Indicates malfunction of the augmentation valve

Operation

Note: *Most of the information in this section is from OM Volume 1, GENERAL, Cold Weather Operations 30.1 to 30.37. It is consolidated here for ease of study. See also* *pages 21-22 of this Study Guide.*

Engine Icing In Flight Indications

Ice buildup on probe may cause engines to indicate TRI power while actually developing less
If this occurs,
- Throttles will retard
- Depending on Autothrottle mode:
  - Airspeed may decay
  - Climb rate may decrease or reverse

Differing rates of ice buildup may cause disparity to be sensed by AT, which will then disengage in EPR LIM mode ...... OM Vol. 1 SYSTEMS 30.6

Engine Anti Ice Use

Continuous ignition ON with engine anti-ice in use

Continuous -**A** or -**B ON** **TWA**

Use any time in icing conditions as defined in Limitations section

ENG L R OFF ON

Turn on one side at a time
- Allow engine to stabilize before turning on other side

Ground Use
- Turn on after each engine is stable after start
- Do not stabilize between 61-74% N_1 (fan blade damage)
- For "significant precipitation" see below
- (See OM Vol. 1 SYSTEMS 75.1, 75.2)

If in light or minimal icing conditions—Engine ignition selector **OFF** ....OM Vol. 1, GENERAL 30.4, (Ground) ***and*** OM Vol. 1, GENERAL 30.7, (In Flight)

Airfoil Anti-Ice Use



Use any time in icing conditions as defined in Limitations Section ***except:***
- Do not use for <u>takeoff</u>, and then <u>turn on at 1000' AFL</u>

When used, Engine Anti-Ice must also be on
Maintain sufficient thrust to keep **ICE PROTECT TEMP LOW** lights out
Pneumatic crossfeed valves open when in use
Minimum Duct pressure 20 psi
After turning on, **L** or **R ICE PROTECT TEMP LOW** light(s) may be on for up to 1 minute

One or both ICE PROT TEMP HIGH light may come on if pneumatic crossfeed levers left open after termination of anti-ice use

WING ANTI-ICE ON

WING ANTI-ICE LIGHT indicates anti-ice heat has been selected for wing leading edge and forward strakes.

Tail De-Ice

TAIL

- When button is pushed
  - Air is diverted to tail for 2 ½ minutes
  - Automatically reconfigured to deice wing leading edges after this perio
- **TAIL DE-ICE ON** light indicates tail heat has been selected

TAIL DE-ICE ON

Exceptional Icing Condition Measures

<u>Ground Use</u> with **"<u>significant precipitation:</u>"**
- Run up engines no more frequently than once every 10 minutes <u>to</u>
  - As high a thrust as practical for
    - 70% N_1 for a minimum of 15 seconds is desired, or
    - Alternately 60% N_1 for a minimum of 40 seconds
    - No more frequently than every 10 minutes
- Subsequent takeoff under these conditions
  - Should be preceded by a static run-up to as high a thrust level as practical *<u>with</u>*
  - Observation of EPR and EGT to assure normal engine operation

Takeoff in known moderate icing conditions
- At pilot discretion use ignition **OVRD**
- Select **CONTIN** as soon as practical after climb configuration established

In-Flight use with severe icing conditions
- Minimum desired N_1 70%
- Thrust reductions below 70% should be
  - ♦No lower than 55% ***and***
  - ♦Limited to 1 minute
- Engines should be run back up to 75% N_1 for at least 1 minute following reduction below 70%....OM Vol. 1, GENERAL 30.7

APU Recommended on Contaminated Runway Landings
- APU should be on prior to final approach
- Provides backup electrical power source if generator(s) are lost due to slush or water ingestion

OM Vol. 1, GENERAL 30.10

After Landing

Leave flaps/slats extended to at least 15 / EXT if
- Making approach in icing conditions ***OR***
- Landing with snow, slush or ice on landing runway

Allows a check of flight controls for damage, and makes deicing easier
Check may be accomplished by deicing personnel or flight crew member ....OM Vol. 1, GENERAL 30.11

Turbulence Considerations

Use speedbrakes to slow airplane
Thrust
- Use smooth power changes
- Maintain thrust as high as possible
- Once set to maintain speed, avoid further changes
- If throttles are in idle when heavy rain encountered. Monitor N_2, as its decay may be the first indication of a spool-down

Don't "chase" speed or altitude
Other Considerations..............................QRH ICE 17-18

Landing Gear

Landing Gear

General

Tricycle Landing Gear
Mechanically controlled—gear handle connected by cable and linkage to transfer valves
Hydraulically operated
- Pressure from right system ***OR***
- Pressure from left system transferred to right system by Power Transfer Unit

Backup Operation with complete hydraulic failure
- Mechanical handle to release uplocks
- Gear free-falls
- Locks down with over-center locks

Spray deflectors on all three gear

Ground Shift Mechanism

Located on Nose wheel
When NOT compressed:
- Disengages NW Steering
- Centers Nose wheel for retraction
- Retracts landing gear handle release button

Activates 2 switches—Switches establish ground or flight mode for other systems
Chart on page LANDING GEAR 10.18 of OM Vol. 2 shows all items affected by ground shift mechanism

Nose wheel Steering

Mechanically Controlled
Hydraulically Actuated
Bypass ValveManually Operated
- Used to disconnect hydraulics from steering actuators for towing

Steering available
- Through rudder pedals—17° L or R
- Through steering wheel—82° L or R
- If Gear Lowered by the alternate system—
  - Right system pressure blocked
  - Less than normal authority to the left

Gear Locking

Main gear locked down with over center linkage
Main gear locking in **UP** position
- Hydraulic pump output **high**, pressure holds gear up
- With pressure **low**, gear rests on main gear doors, which are locked up by uplocks

Nose gear locking—Over center locks up and down (See OM Volume II LANDING GEAR 10.11)

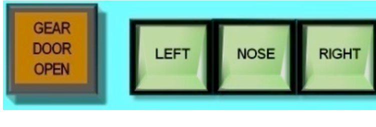
Gear Doors

Main Gear
- Main Gear doors hydraulically actuated
- Outboard Gear doors mechanically linked to gear movement

Nose Gear has 4 doors
- 2 Aft doors are linked mechanically to gear
- 2 Forward doors can be opened manually on ground for work in nose wheel bay

Landing Gear Status Lights

Position Lights



- Green—Gear handle down and associated gear in down-and-locked position
- Red
  - ♦Any unsafe gear condition ***or***
  - ♦Landing gear in transition ***or***
  - ♦Landing gear not in agreement with gear handle ***or***
  - ♦Gear handle down & any gear not locked down ***or***
  - ♦Gear up & locked & either or both throttles closed

GEAR DOOR OPEN Light On any time main gear doors are not locked closed





Landing Gear Warning Horn and Aural Warning

Warning Horn
- Sounds when
  - Below 1000' AGL on Captain's RA* ***AND***
  - Airplane below 210 Knots ***AND***
  - One or both throttles closed ***AND***
  - Gear not down and locked
  - * If Captain's RA inop, sounds at any altitude with above conditions
- May be silenced by pedestal-mounted button unless
  - Gear not down & locked ***and*** flaps extended over 26°

Aural/Vocal Warning
- Landing Gear not down and locked
- Flaps extended beyond 26°
- May ***not be silenced*** until gear is lowered or flaps < 26°
- Aural Warning ....LANDING GEAR"

Gear Down Verification with Power Loss

Main Gear
- Periscope between 3rd & 4th windows aft of aft overwing exit
- Cover may only be removed when cabin is depressurized

Nose Gear—Pedestal-mounted pin extends when nose gear is locked down

Brakes

General

Brake actuators on **each main gear**
Powered by both hydraulic systems
Components
- 4 Disc pistons on each wheel from each hydraulic system
- 8 Power pistons per wheel
- Accumulator on each main gear
  - Sufficient for approximately 5 brake applications
  - Brake pressure indicator monitors hydraulic pressure on each system
- Brake temperature gage

Parking Brakes

Effective if brake pressure gage is above the RED arc
Aural warning if ON and throttles advanced for takeoff
PARKING BRAKES ON Light
- Parking brake set
- If on with brakes not set, indicates antiskid malfunction

Wheel Not Turning Light

Speed difference between **fastest** and **slowest** main gear wheel exceeds 20%

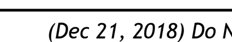
Anti-Skid

Armed by switch on overhead panel
- **ARM**—After main wheel spin up, allows anti-skid system to modulate brake pressure to prevent skidding
- **OFF**—Disarms Anti-skid & Acts as a reset position

Circuit caution lights
- Separate lights for each circuit (**INBD** & **OUTBD**) on each side (**L** & **R**)—4 lights
- Indicate one of the following:
  - Respective circuit failure is detected
  - Anti-skid arming switch is off
  - Test switch in TEST, if gear are down

Deactivated by (LAPS):

Landing gear handle not in down detent
Arming switch OFF
Parking brakes set
Slow taxi speed (Below approximately 10 knots)



Brake Temperature

Gage and warning light indicate temperature

Excessive temperature may result in tire fuse plug melting & loss of tire pressure

Key Temperatures

Max temperature for takeoff ....205°C

Overheat light ....ON at 305°C, OFF at 260°C

Hot Brakes ....200-400°C

Overheated Brakes ....>400°C

Maximum to set Parking Brake ....300˚C

Brake Temperature Test Button ....425-475°C

...............and **OVHT** Light ON with button depressed

Brake Wear Indicator Pins

Limits, with ***brakes parked***—pins must extend beyond brake housing as follows:

MD-82s—Pin flush or greater

MD 83s—Pin extended more than ½" above flush

See OM Volume 1, PRE-FLIGHT 10.14 and LIM 10.31

Automatic Brake System

ABS Takeoff Mode Arming (FAAST)

Flaps positioned to less than 26°

ARM-DISARM Switch to **ARM**

Anti-Skid **ARM-DISARM** Switch to **ARM**

Spoilers Stowed

T. O. Position on **AUTO BRAKE** selector

Take-off warning sounds if ABS not armed with spoilers armed, and vice versa



ABS Landing Mode Arming (AAA)

Anti-Skid Armed

ABS Switch in a LDG range (Not OFF)

ABS Arming switch to ARM

In addition to the above conditions, the landing gear handle must be down to arm ABS for landing

ABS Activation on Landing

Throttles retarded below 22°

Brake pedals NOT depressed

Spoilers deployed (manually or automatically—***see page 38***)

Automatic delays following spoiler deployment (allows for nose wheel touchdown):

1 Seconds in MAX

3 Seconds in MED or MIN

ABS Deactivation

Brake system reverts to manual braking if any of the following occur (**F TABS**):

*Flaps raised to less than 26° with speed above 70 knots (Below 70 knots, raising flaps to less than 26° does **not** discontinue ABS)*

Throttle—Either advanced beyond 22° above idle

ARM-DISARM Switch to DISARM

Brakes—Either brake pedal depressed more than 25%

Stowing Ground Spoilers

Releases brake pressure without disarming ABS

Re-deploying spoilers will reactivate ABS until it is disarmed by any other means

At ABS disarming, the following occur:

ARM-DISARM Switch drops to DISARM

ABS Lights come ON

Rejected Takeoff (TO) and ABS

Rejected takeoff is signaled to ABS by spoiler handle moving aft manually or automatically

Takeoff rejected below 70 Knots

ABS reverts to landing mode

MIN braking force applied

Rejected takeoff above 70 Knots

MAX Autobraking

T.O. Is the ***only auto mode*** which uses ***both*** hydraulic systems

Other modes (**LAND MIN**, **MED**, and **MAX**) use ***only*** right system .See schematic, OM Vol. II p. LANDING GEAR-10.17

Pilot takeover initiated by:

Throttle(s) forward

Brake pedal(s) depressed

ABS Fault Detected

Causes the system to **DISARM**

Results:

ARM-DISARM Switch drops to **DISARM**

AUTO BRAKE FAIL Light **MC**

AUTO BRAKE FAIL

ABS Lights come **ON**

Rearming Autobrake following fault detection

AUTO BRAKE Selector switch to **OFF**, then to desired deceleration setting

ARM-DISARM Switch to **ARM**

Autobraking will resume if the fault has cleared

Preflight Tire Checks

Tire Inspection / Replacement Guide gives guidance for tread wear considerations.............OM Vol. 1, SYSTEMS 80.1-80.3

Miscellaneous Systems

Lighting

Strobe Lights
Forward and aft wing strobes mounted at wing tip
ON When:
POS/STROBE Switch in BOTH
Nose wheel off the ground

Landing Lights
Nose Lights
Two bulbs
ON When landing gear handle is DOWN with switch on
Wing Tip Retractable Landing Lights
Separate switch positions for **EXT OFF** and **EXT ON**
Extend when Switch in **EXT** (**EXT OFF** or **EXT ON**) ***and***
Both engines running ***or***
One engine running with gear extended
On Single-Engine Go-around, lights turn off and retract
Design allows for automatic retraction in the event of engine failure and subsequent go-around
Note: Control may be regained after engine failure logic activates by cycling switch to **RET** and back to **EXT**

Potable Water Systems

Water Shutoffs
See OM Volume II, MISCELLANEOUS 60.1, 60.4 for location
Valves can be turned past CLOSED position, so use care in turning OFF to ensure proper position is not passed
Water flow ceases approximately 30 seconds after valve is turned OFF

Water Servicing Point
Guarded switches should be closed on pre-flight
To get water pressure to lavatories and galleys:
Fill & Vent Valve Switch (Some airplanes)—Must be in CLOSE (Guard Closed)
Water quantity Mode Selector (Some airplanes)—Must be in OFF
One pack must be ON for pressure

Passenger Information Signs

NO SMOKING (NS) Signs & Switch
Switch Positions—all deactivated
Placard—installed over light (does not illuminate)

FASTEN SEAT BELT (FSB) Signs
Switch activates **FASTEN SEAT BELT** and Lavatory **RETURN TO CABIN** Lights
AUTO—ON when Slats are extended
ON/OFF—Self Explanatory
Note: *Cabin over 10,000 Feet—FASTEN SEAT BELT signs come ON automatically*

Flight & Cockpit Voice Recorders

Digital Cockpit Voice Recorder
Stores 2 hours of voice data
Uses solid state technology rather than tape
Airplanes manufactured after October, 1991
Require boom mics
Placard installed on both sides of instrument panel:

BOOM MIC REQUIRED BELOW FL180 ON THIS AIRPLANE

TEST Button
Pressed for 5 seconds
Tests all channels
Test monitor meter
Needle does not move until all channels have been tested
Needle then goes into green band if test is good, remains there until button released

ERASE Button—Tape erased in these conditions:
♦Button held for two seconds ....♦Parking brake set
♦Airplane on ground ....♦AC Power available
Note: Do not hold longer than 5 seconds

Flight Data Recorder
NORM—Flight Data Recorder runs when
Parking brake is released and
Either fuel lever is ON
GND TEST—Interlocks (above) are bypassed
FLIGHT RECORDER OFF Status Light
Recorder is de-energized
Tape is broken, exhausted, or not winding properly



Cockpit Oxygen System

Oxygen Supply
Single high-pressure gaseous cylinder
Located in cockpit behind F/O seat
Pressure—1100 psi at 70°F
Shutoff on bottle
Thermal discharge disc outside airplane, right side, indicates bottle expended

System Use
Diluter Demand Control
100% OXYGEN—provides 100% O_2 at all altitudes
NORMAL—
O_2 is mixed with ambient air to maintain acceptable volume of O_2 to the pilot for the current altitude
Above 28,000'MSL, O_2 is delivered under pressure
Emergency O_2 Switch
EMERGENCY—
Provides O_2 under pressure to pilot's mask
Pin must be pulled to place switch in this position
Feature provides a backup means of getting high pressure O_2 in the event of a failure of the normal system above 28,000'
NORMAL—Diluter Demand Control switch determines O_2 flow rate
TEST MASK—
Supplies O_2 under pressure for checking mask and hose assemblies
Spring-loaded back to NORMAL position

Flight Attendant & Cabin Oxygen Systems

Flight Attendant Portable O2 Cylinders
Four bottles located in cabin
Pressure—1800 psi
Normal flow—30 minutes
Flow Rate—4 Liters per minute

Passenger Oxygen
May be provided by AA with prior coordination for passengers with medical needs
Passengers may NOT provide their own oxygen
Security concerns—canister could contain anything...

Passenger Oxygen System

Components
Chemical O_2 Generators
One at each position (See below)
Generate O_2 for at least 15 minutes
Generation rates, and therefore flow rates are low
When activated, an odor results which can be disconcerting if not expected

O_2 Reservoir bags
- Collect generated O_2 between breathing cycles
- Bag will likely not inflate, depending on:
  - Cabin altitude
  - Time since generator activated

Inflation indicator
- Small green bag at inlet end of mask reservoir bag
- Inflates slightly when O_2 is flowing

Individual Unit Locations:

Each Passenger Row
- Three-seat rows (right side) have four masks
- Two-seat rows (left side) have three masks

Forward And Aft Flight Attendant Stations (Mid Attendant seat gets O_2 from one of the passenger-type overhead masks)

Lavatories—None (All removed)

Activation

Automatic—Cabin above **14,000'** pressure altitude
- Doors open
- Any one mask being pulled down to separate lanyard from O_2 generator starts O_2 flow from the generator to all masks in the unit

Manual Override
- **EJECT**—Opens all O_2 compartment doors
- Hold switch 3-5 seconds, but not over 5 seconds

Power
- Left AC & DC normally power door activation
- If power loss occurs, right AC & DC provide power

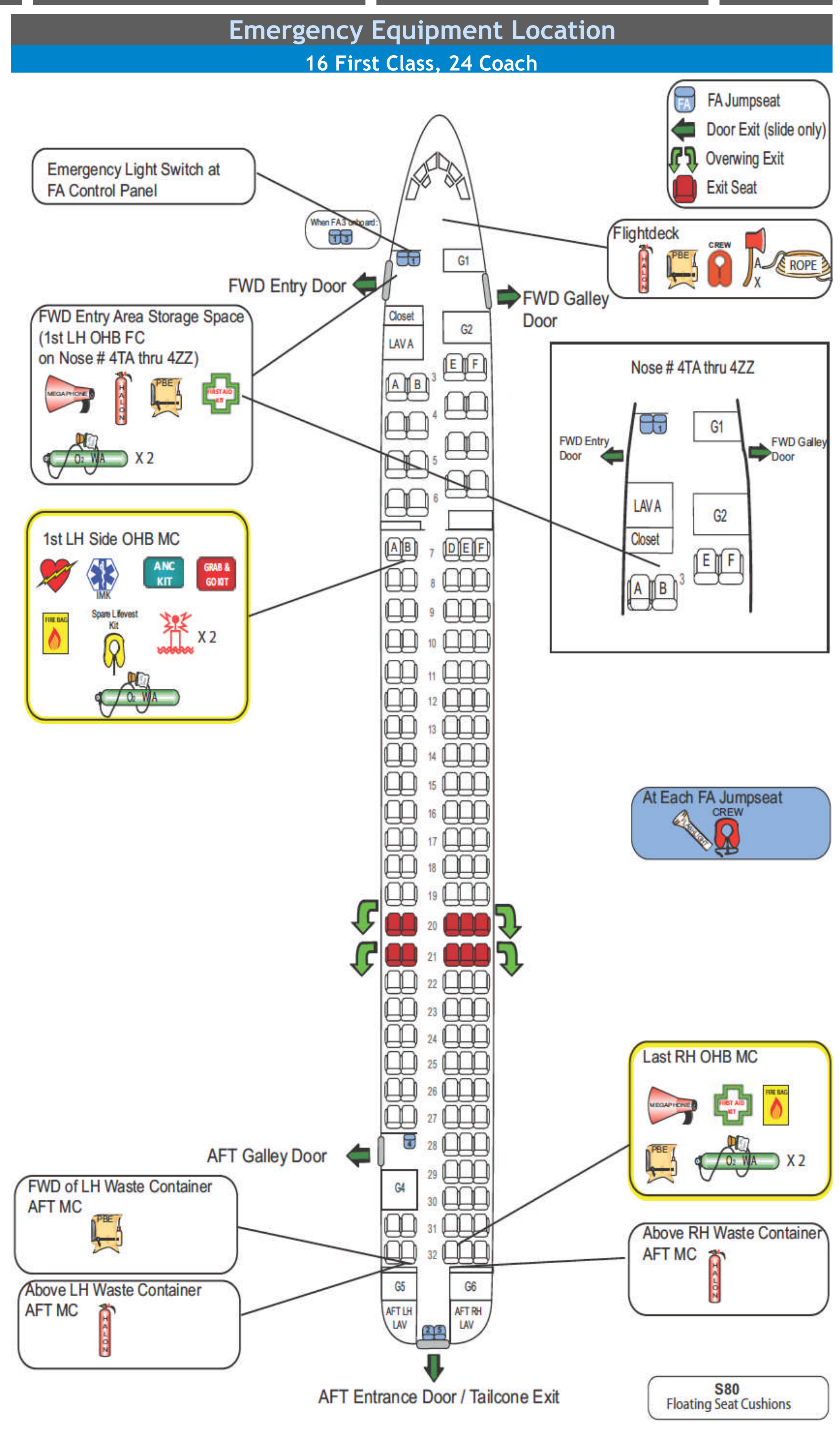
Cabin Oxygen On Light

CABIN OXYGEN ON

Indicates Electrical power has been applied to O_2 compartments door solenoid

Emergency Equipment Location

16 First Class, 24 Coach



Reference—OM Volume 1, GENERAL 15.6

Navigation

Compass Systems

Two independent systems
- Each system stabilized by an associated directional gyro
- Magnetic inputs from an associated flux valve
- Displayed at all times except when RAD / NAV switch is in NAV

Compass system 1 provides inputs to
- FO compass indicator
- Captain's ND, VOR / LOC 1
- Digital Flight Guidance System (DFGC) 1 & 2

Compass system 2 provides inputs to
- CA compass indicator
- FO's ND, VOR / LOC 1
- Digital Flight Guidance System (DFGC) 1 & 2

VHF Navigation Systems

Two independent systems
- VOR / LOC 1, controlled by CA VHF Nav Control Panel
- VOR / LOC 2, controlled by FO VHF Nav Control Panel

VOR / LOC 1 provides inputs to
- CA ND and PFD
- CA and FO Compass indicators
- DFGCs 1 and 2

VOR / LOC 2 provides inputs to
- FO ND and PFD
- CA and FO Compass indicators
- DFGCs 1 and 2

Automatic Direction Finding (ADF) Systems

Single ADF

Control panel on forward pedestal
- Selects operating mode and frequency
- Displays on both CA and FO **VOR / ADF 2** pointers

Displays
- Two VOR / ADF selectors on each compass indicator
- Only the right ADF selection position functions

Marker Beacon System

Pre-tuned

Provides visual and aural signals to three dimmable lights on CA and FO instrument panel

Warning & Alert

Warning & Caution Lights

MASTER CAUTION Light



Illuminates for activation of certain individual caution lights on annunciator panel

Pressing either light extinguishes both **MASTER CAUTION** Lights and reset the system for subsequent indications.

MASTER WARNING Light

Illuminates for activation of certain individual caution lights on annunciator panel

Pressing either light extinguishes both **MASTER WARNING** Lights and reset the system for subsequent indications.

GPWS

Ground Proximity Warning System

GPWS Warning Categories GPWS Warnings can be divided into 5 general categories:
- ♦Excessive Sink Rate
- ♦Excessive Terrain Closure
- ♦Altitude Loss after Takeoff
- ♦Descent in Wrong Configuration
- ♦Descent below Glideslope

GPWS Mode Summary

Gives warnings for 5 modes/terrain closure situations

Excessive Descent Rate, 50-2450 Feet AGL

Ⓢ*Repeated every 0.75 sec.* .... ***Sink Rate, Sink Rate***

Ⓗ*Continuous* .... ***Whoop-Whoop Pull-Up***

Excessive Terrain Closure, 0-2450 Feet AGL

≈30 Seconds to Ground @2500'

≈20 Seconds to Ground @1000'

≈10 Seconds to Ground @500'

Ⓢ*Rapid Succession* .... ***Terrain-Terrain***

Ⓗ*Repeated every 0.75 sec* .... ***Whoop-Whoop Pull-Up***

Altitude Loss after T/O (65-700 Feet on takeoff; or following gear or flap retraction <200 feet on Go-around)

Repeated every 0.75 sec .... ***Don't Sink***

Terrain Clearance, in Wrong Configuration

Gear Up Below 500'

<.35M- Repeated every 0.75 sec .... ***Too Low Gear***

>.35M- Repeated every 0.75 sec. .... ***Too Low Terrain***

Gear Down, Flaps not in Landing Position Below 1000'

<.29M, 50-200'-Repeated every 0.75 sec .... ***Too Low Flap***

>.29M, 50-1000'-Repeated every .75 sec.... ***Too Low Terrain***

Below Glideslope ? 1.3 Dots <1000' RA

Aural Warning (Repeated) .... ***Glideslope***

Function Ⓢ-Soft Warning Ⓗ-Hard Warning

Notes:
- ♦*Above examples and numbers are "ballpark only," intended for familiarization.*
- ♦*See Charts, pp. WARNING & ALERT 20.3 - 20.8 for details*
- ♦*For all of the above, **GPWS** and **GLIDESLOPE** Warning Lights (as appropriate) illuminate*
- ♦*Hard Warnings Ⓗ occur at performance approximately 10-15% more severe than Soft Warnings Ⓢ in Mode 1, and 20-40% in Mode 2.*

GPWS Fail Light

Self Explanatory

GPWS FAIL

CADC Inputs

CADC 1 provides barometric sink rate

No switch to CADC 2 is possible

Enhanced GPWS Features (EGPWS)

General

Major features:

Worldwide database with all runways over 3500' long

(Not all of these can be displayed in map mode)

Terrain data from worldwide database can be shown

Warning capability if airplane flight path predicted to intersect terrain within specified criteria

Does not override non-enhanced GPWS—same warnings based on radio altimeter and descent rate combined with airplane configuration still in effect

Uses GFMS to compare airplane position to terrain database

Alerts

Caution Alert

Criteria—40-60 seconds from predicted terrain conflict

Conflict criteria

Within about $1/8$ mile either side aircraft

The initial distance of $1/8$ mile ($1/4$ mile wide) expands ±3° from both sides of aircraft as the path is projected forward

Aural alert, amber **TERR** annunciation on

ND (EFIS airplanes) or

Weather radar indicator (non-EFIS airplanes)

Illuminated **GPWS** light

Warning Alert

Criteria—20-30 seconds from predicted terrain conflict

Alerts—same as caution, except red **TERR** annunciation

Terrain Clearance Floor (TCF) feature

For all runways over 3500 feet long, specific terrain alerting

Creates terrain clearance envelope directly related to distance from the runway

Approach and departure

Criteria modified to avoid nuisance alerts

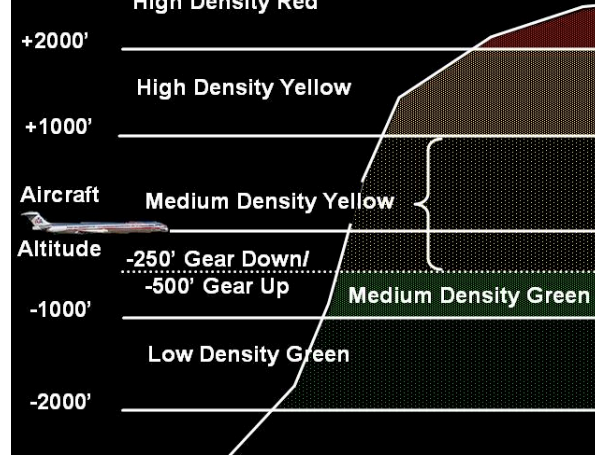
EGPWS Uses FMC data for proximity calculations

Inaccurate FMC position data can compromise EGPWS warnings

Man-made obstructions are ***not*** programmed

Display

Variable density dot patterns (All altitudes with respect to airplane altitude)



Display available in MAP or ARC modes:

Green TERR message annunciated when active

Activating display

EGPWS uses same line to HSI as weather radar

Weather radar and **TERR** must be **on** to display terrain data

Terrain and weather ***cannot*** be simultaneously displayed on the same HSI (*Can* be displayed on opposite sides of the cockpit, however)

Automatic activation—potential conflict will activate EGPWS display and appropriate warning ***if***:

Weather radar is **ON**

Terrain System Override Switch not in **OVRD**

Traffic Alert & Collision Avoidance System (TCAS)

General

Display
TCAS display on dedicated TCAS Indicator
Radar on Navigation Displays (ND)

♦**Resolution Advisory** (TA/RA) Mode may be selected as close to the departure runway as practical

♦**May be left in TA/RA** until after landing

TCAS Operating Policy

Conflict between RA and **ATC**—follow RA
Return to ATC clearance after ***CLEAR OF CONFLICT***
Advise ATC of deviations

Once RA issued, maintain speed as computations based on speed at the time

High-speed buffet—relax pitch as necessary to reduce buffet, but continue the maneuver

Visual contact made with traffic—Maneuver as required is allowed, however
If following the TCAS direction will accomplish deconfliction, it should be followed
Visual contact could be with incorrect traffic

Responding to RA, maneuver only as much as needed to satisfy the RA

Other critical warnings take precedence over TCAS
Windshear
GPWS
Stick shaker or initial buffet—accomplish stall recovery procedure ....See QRH MANEUVERS 10

Altitude Band Selection

ABOVE—
Used in Climb
Traffic displayed -2700 to +8700 from present altitude

NORM—
Used in cruise
Traffic ±2700' from present altitude

BELOW—
Used in Descent
Traffic +2700 to -8700' from present altitude

Traffic Symbols and Warnings

Other Traffic ....White Open Diamond 
More than 6 miles away *OR*
Over 1200' altitude differential

Proximate Traffic.........................White Filled Diamond
Within 6 Miles *AND*
Within ± 1200' altitude

Traffic Advisory (TA) Intruder ....Amber Filled Circle
A target whose altitude is projected to be within ±900' at point of closest passage
TA Alert occurs at 40 seconds from point of projected closest passage
Aural Warning ....*"Traffic Traffic"*

Resolution Advisory ....Red Filled Square
A target whose altitude is projected to be within ±600' at point of closest passage
Threat is 25 seconds from closest point of approach
Vertical avoidance maneuver displayed on IVSI
Aural Warnings ....See OM Vol. II, WARNING & ALERT 60.15

TCAS II System

Installed on all aircraft

Requires flight crew response
Within 5 seconds of initial RA
Applying G-forces of ±.25 G
This is more than AP can supply, so response must be hand-flown (*no change from previous TCAS policy*)

RADAR

Antenna Control

Stabilized in Pitch and Roll

Inputs to stabilization—
Normal—VG 2
VERT GYRO Switch in R on AUX—Aux Gyro

Controllable range
Tilt: ±15° Pitch
Range: 10, 20, 40, 80, 160 & 320 NM

Color Codes

Red—High density precipitation
Yellow—Medium intensity precipitation
Green—Low density precipitation
Black—Precipitation levels below pre-set threshold

Fault Monitoring

Automatic checks occur for system faults
Fault codes are displayed on Radar Indicator
Line Replaceable Unit (LRU) faults displayed only when mode selector is in **TEST**

Spoking
Caused by external interference
Not a system fault unless it continues for a long period of time

Performance

Editor's Note: Very few Performance Section items are expected to be known during orals and review sessions. But, (you guessed it!) there are a few. A few relatively common ones are summarized here.

TPS Computations

All TPS basic performance numbers are for dry conditions
Must apply contamination correction for wet runways

Standard Takeoff Thrust Not Authorized

Weather 4
- **Tailwind**
- **Contamination:** Contaminated Runway
  - Standing Water
  - Slush
  - Snow (wet or dry)
  - Ice
- **Windshear** reported or expected
- **Temperature** (Actual) hotter than Max Temp Standard (MTS)

Weight 2
- **Closeout**—Actual TOW from closeout is greater than Assumed Takeoff Weight
- **MEL/CDL Items** which specify MAX thrust required:
  - MAX-PNLT appears in the assumed temperature column
  - Conditions where weight correction is required and takeoff data is not automatically corrected by TPS

Airport 1
- **Mandated**—Flight Manual Part II Airport Advisory specifies use of MAX Thrust

See Performance Manual, TPS-10.4

Speed Assumptions

Built into flight planning computer algorithms

MAX	STD	MIN
.79	.76	.66

Follow fuel conservation cost index considerations in flight plan
Initial planning is done at STD Mach
If block to block is less than scheduled, lower Mach number plan is generated
Iteration continues until LRC "Floor" is reached or block time equals schedule
Final time is designed to represent lowest cost option, including crew costs and other known and programmed variables

Cruise Considerations

If temperature is warmer than planned
TAS increases 1 knot for each degree *warmer*
If EPR gage is inoperative
Match N_1 to engine with operative EPR gage
Below 320 knot/mach crossover
320 Knot cruise is computed

MAX Takeoff Weight (MTOW) codes (LASTED)

L=*Landing Weight Limit*
A=*Load Agent Adjusted Limit*
S=*Structural Weight Limit*
T=*Takeoff Weight Limit, based on climb or runway limited weights*
E=*Enroute Considerations*
D=***Dispatcher Adjusted Limit***

Snow, Ice, or Slush Corrections

Flap Settings authorized: 11 or 17° ***only***
Separate slush/wet snow tables for ½" and ¼" of slush
No correction required for 1½" or less of dry snow
Use ½" Slush table for:
Ice Conditions
1½ to 3" of dry snow

Contaminated Runways

A runway should be considered contaminated when:
More than 25 percent of the required field length, within the width being used, is covered by:
- Standing water, slush, or wet snow deeper than 1/8" (3 mm)
- Dry snow deeper than 1 inch (25 mm)
- Ice

If a runway is contaminated:
- Takeoff is not authorized with a tailwind
- Takeoff is not authorized with
  - More than 1/2 inch of wet snow, slush, ***OR***
  - Standing water, ***OR***
  - More than 4 inches of dry snow
- Maximum thrust must be used
  - If ART (MEL item 73-8) is inoperative use Reserve thrust. Standard thrust is not authorized
- Both thrust reversers must be operative
- APU will be used for takeoff, if operative.
  - APU Air Switch is **OFF**
  - APU Bus Switches are **ON**)
- Takeoff not authorized with chunks of hardened snow or ice
- Corrections to V1 and maximum weight allowances are made by dispatchers and sent to aircraft

Performance, TAKEOFF 40.1
Repeated on page 22 of this Study Guide

Automatic Relay Summary

Note: *The table on this page is designed to assist in sorting out the various automatic functions and which actions are required to arm, disarm, and activate each. No attempt is made to include the actions resulting from activation, as these are generally self-explanatory. The Auto Pack Shutdown, for instance shuts down the packs when it is armed and activated. For each column, the page number for expanded notes in this* **Study Guide** *is given at the top of the column.*

Where multiple conditions are listed all, must be satisfied unless indicated otherwise	Auto Pack Shutdown	Auto Spoiler	Auto Brakes	ART	ATR	Anti-Skid	AutoSlats
Operating Manual:	AIR 20.1	FLT-C 20.5	LAND 20.5	ENG 20.8	ENG 20.6	LAND 20.3	FLT-C 20.9
TAKEOFF Study Guide:	Page 24	Page 38	Page 48	Page 34	Page 34	Page 47	Page 39
Engines—one or both running Pack Supply Switches (one or both) in **HP BLD OFF** or **AUTO** AUTO selected—Air Conditioning Shutoff Switch Differential Pressure (cabin to ambient) below 1.3 psi	ARM						
Differential 13th stage pressure (delta P) of 70 psi or more as failed engine spools down	ACTIVATE						
Airborne through approx. 3000 feet AFL	DISARM						
Air Conditioner Shutoff Switch to **OVRD**	RESET						
Squeeze & Raise Spoiler lever		ARM					
Reverse thrust selected		ACTIVATE					
Flaps positioned to less than 26° Auto Brake **ARM-DISARM** Switch to **ARM** Anti-Skid **ARM-DISARM** Switch to **ARM** Spoilers Stowed T. O. Position on **AUTO BRAKE** selector			ARM				
Spoiler handle out of full forward (auto or manual) 1 Second delay **MAX**, 3 Second delay **MIN** or **MED**			ACTIVATE 1 - 3 sec delay				
RTO Above 70 Knots			ACTIVATE MAX				
RTO Below 70 Knots			ACTIVATE MIN				
Throttles retarded below 22° Brake pedals NOT depressed Spoilers deployed (automatically or manually)			ACTIVATE				
Flaps raised to less than 26° with speed above 70 knots *OR* *(Below 70 knots, Raising flaps to less than 26° does not discontinue ABS)* Throttle—Either advanced beyond 22°* *OR* **ARM-DISARM** Switch to **DISARM** *OR* Brakes—Either brake pedal depressed more than 25% *OR* Stowing Ground Spoilers* *Note: *Both items inhibit autobrakes—they will be reapplied if criteria reversed.*			DE-ACTIVATE (Released)				
Self test complete and **READY** Light ON Both engines above 64%				ARM			
30% N_1 Difference				ACTIVATE			
Before Slat Retraction—Both engines retarded below 58% N_1				TEMP DISARM			
Power on both engines advances above 64%				RE-ARM			
Slat Retraction				DISARM			
Takeoff—Flight director in take-off (TAK OFF) mode Altitude—Radio Altitude over 350 feet Power—Both engines operating below Go-Around power Note: *If engine failure occurs below 350 feet, ATR does not engage when altitude reaches 350 feet. (See added notes page 28)*					ARM		
Vertical speed decreases below 0 fpm for five seconds *OR* EPR drop ≥0.25 *and* N_1 loss ≥7% on the same engine					ACTIVATE		
Any pitch mode selected on DFGC					DISARM		
Anti-Skid Switch to **ARM** Main Wheel Spin Up						ARM	
Skid Sensed by Anti-Skid Computer						ACTIVATE	
Landing Gear not Down Arming Switch OFF Parking Brakes Set Slow Speed Taxi (Approx. 10 knots)						DISARM	
Speed below 240 knots Flap/Slat Handle in 0 to 13 T/O (EXT) range							ARM
Either stall-warning computer detects approach to stall							ACTIVATE

LANDING: (*Only Differences are listed below; Arm/Disarm/Activation conditions above apply where appropriate.*)

	Auto Pack Shutdown	Auto Spoiler	Auto Brakes	ART	ATR	Anti-Skid	AutoSlats
Spoiler lever raised		ARM					
Flight Spoilers: Main Wheel spin up *OR* Nose Strut Compression Ground Spoilers Added: Weight on Main Gear and Throttles Idle		ACTIVATE					
Throttles forward for go-around after spoiler deployment		DISARM	DISARM				
Anti-Skid Armed ABS Switch in a LDG range (Not **OFF**) ABS Arming switch to **ARM**			ARM			ACTIVATE/ DISARM *as above*	
Spoilers activated—see above: **MAX**—1 second delay after spoilers activated **MED** or **MIN**—3 sec delay after spoilers activated			ACTIVATE				

Operational Notes and Lists

__Disclaimer__: *On this page and the one following page are lists and consolidated information which have operational relevance. These lists are intended as a starting point for consolidating each pilot's personal notes, and the reproducible pages here are*

For Training Purposes Only

This material is provided in an effort to help in consolidating policy guidelines for planning purposes. It is __not__ an attempt to replace Operating Manual guidance from which these notes are derived.

AutoBrakes

Must be armed (If operative) for any of the following:

- Runway
  - Less than 7,000'—Auto Brake
  - Contaminated—standing water/snow/slush/ice
- Weather
  - RVR less than 4000 or visibility less than 3/4 mile
  - CAT II or III Approaches—Autobrakes armed if operable
  - Braking conditions reported less than good
  - Minimum Stopping Distance situation—use of MAX req'd

Recommended: landing with gusty winds or crosswinds

OM Vol. 1, APP, LDG, G/A 10.3, 40.2, 40.5

Flaps 40 Landing

- **Normal flap setting for landing** is flaps 28
  - Conserves fuel vs. Flaps 40
  - Flaps 28 normally used:
    - —On dry runways more than 7,000' long
    - —At airport elevations over 6,000' MSL
    - —May be required at other airports
- **Autoland** authorized for flaps 28or 40.
- **Flaps 40 required** at airport elevations 6,000' MSL or less when any of the following apply:
  - —Tailwind
  - —Wet / slippery runways
  - —Braking action less than good
  - —Captain's judgment
- **Flaps 40 helps reduce** overall stopping distance

OM Vol. 1 APP-LDG_G/A 10.4-10.5 , 50.2-50.3

Maximum Flap and Gear Speeds

0-13°—280	26-27°—200	__Gear__	Extension 300 / .70M
14-20°—240	*MD-83—205*		Extended 300 / .70M
21-25°—220	28-40°—195		Retraction 250 / .70M
	MD-83—200		OM Vol. 1, LIM 10.6

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Standardized Actions

Callouts—Bold Italics Actions-Non Bold PM Actions GreenGear

Takeoff	2 Engine Go-Around	Takeoff Engine Failure	1 Engine Go-Around
Autothrottle—ON *Thrust Set* *80 Knots—Check* *V_1* *Rotate* *V_2* *V_2+10* *Positive Rate,* *Gear Up*	*Go-Around* *Set Go-Around Thrust* *Flaps — 15* (or *Flaps 11* as required) *Positive Rate,* *Gear Up* *Set and Arm Missed Approach Altitude*	*Autothrottle—ON"* *Thrust Set* *80 Knots—Check* *V_1* *My Aircraft* *Rotate* *V_2* *Positive Rate,* *Gear Up* *Runway Heading, HDG SEL*	*Go-Around* *Set Go-Around Thrust* *Flaps 11* VREF + 5 Minimum *Positive Rate,* *Gear Up* *Runway HDG, HDG SEL* *Set and Arm Missed Approach Altitude*
Passing 400' AGL Minimum			
HDG SEL or *NAV*	*HDG HOLD, NAV* or *HDG SEL* *Set Speed 200*		
Passing 500' AGL Minimum			
Autopilot ON (if desired)			*Set Speed 250*
> 1000 AFL		**EOAA**	**> 1000 AFL**
Half Rate *Climb Power* *Flaps Up* (on schedule)	*Half Rate* *Climb Power* *Flaps Up* (on schedule) *Speed Select*	*Altitude Hold* *__If Engine Fire or Severe Damage__:* __Memory Items__ Autothrottle...OFF Throttle Affected Engine..Confirm ....IDLE *Flaps Up* *Slats Retract* (On Schedule)	*Altitude Hold* *Flaps Up* (On Schedule)
0/EXT			**0/EXT**
Slats Retract			*Slats Retract*
		0/EXT+ 20	
Clean Min Maneuver IAS, Bank 30 **2500' AFL** *IAS 250* or *SPD SEL 250* or *PERF* or *VNAV*		*IAS* *A/C Override* *SET MCT* *Checklist*	*IAS* *A/C Override* *SET MCT* *Checklist*

OM Vol. 1, General 15.4

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MD-80 Briefings & Notes

Flight Attendant Briefing

Number of F/A's on board
Known delays
Ground—Short-taxi & safety demo considerations
Turbulence
- Weather and turbulence forecast for route
- Unexpected turbulence
- Notification
- Required action in the event of a significant encounter
  - Service suspension at F/A's discretion
  - When able, call CA to report cabin situation / injuries
  - If no access to interphone, remain seated, avoid injury
  - Resuming Duties
  - Once cleared to resume call flight deck to report any injuries or abnormalities.

Security items
E6 Cabin Items
Life vest demo--overwater segment
Gen Declarations/Customs Immigration forms (if req'd).
Cockpit Access
- Crew meals
- Cockpit Door

Cabin Door Handles—Push Down
Any other unusual issues relevant to the flight

FM Part 1, page 7.1-3

TEST Briefing

T—TYPE of emergency
E—EVACUATION will be accomplished after landing
S—Evacuation SIGNAL to be used
T—TIME to landing

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Takeoff Briefing

Pilot Flying
Rejected T/O
<80—Unusual Indications
>80—Eng **Failure**, **Fire**, **PWS**, **Unsafe**
Contingencies
Wet Runway — See PERF TAKEOFF 10.2
Departure
Apt Specific Eng Out
TO Alternate
<330NM, must accommodate engine out approach
T/O Weather Considerations
R/W Surface Considerations
Terrain
Other Taxi/T/O Variables & NOTAMS

FM Part 1, page 8.2-1; OM Vol. 1, STARTING 10.9

Standard Thrust Not Permitted

Maximum Thrust Required
Tailwind
Runway contaminated with standing water, slush, snow, ice
Windshear reported / expected
TOW > ATOW (*Can get new TPS*)
Improved Performance used
When FM-II Airport Advisory requires Max
MEL / CDL items
With weight corrections ***not*** included in TPS
With prohibitions of Standard Thrust
Engine Anti-ice used; TPS not planned for A/I

Reserve Thrust Required
ART System inoperative, and Performance Manual does not authorize standard thrust

Note: *It is the Captain's responsibility to ensure that no condition exists that prohibits use of standard Thrust even though it appears on the TPS.*

Performance-TPS 10.4
OM Vol. 1, Taxi-Takeoff 30.6, LIM 10.18

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Single Engine Taxi Guidance

Not authorized when:
Jet blast will be excessive
Ramps & taxiways slippery
Icing conditions
—No significant precipitation (snow, sleet or freezing rain) occurring that could adhere to / collect in engine inlet.
—The engine inlet will be checked by Maintenance or authorized deicing personnel prior to restart.

Before Takeoff APU recommended for SE taxi
After Landing APU not required, but consider:
All galleys and overwing heaters shed
AC Load limitation is 1.0—may need to turn off non-essential equipment
If cabin temperature uncomfortable—restart APU

Cautions and Considerations
Avoid excessive jet blast in ramp areas with high weight
Size of aircraft following may be a factor
Monitor L and R fuel tank quantities for imbalance
Restart may be accomplished while taxiing at Captain's discretion

OM Vol. 1, TAXI-TAKEOFF 10.2
AFTER LANDING-Parking 10.3

Common Sense Issues—May not be advisable when:
Braking Action Less than good
MEL items involving normal / back-up modes of
◆Generators ◆Hydraulics ◆Steering & Brakes
Proximity of the gate to departure / arrival runway
Tight turns in confined areas expected

Approach Setup—WARM-V

Initial Setup—"WARM"
Weather requirements & NOTAMS—Check
Include crosswinds, visibility, published minimums
Approach—Plan and brief approach
RNP—Check chart & Set As Required for the Approach
MCP—When cleared for the approach—Select APP Mode
Set FAF altitude when on intercept or a portion of the approach

Note: *These are techniques extracted from various sources*

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Passing FAF Actions

Passing FAF Actions—MAC-V
Missed Approach Altitude—Set when 300' below MAP
APPR Light—Green (RNAV Approaches)
Clearance—Tower Call Passing FAF
V/S—Set as required
Note: *These are techniques extracted from various sources*

Final Approach Deviation Callouts

Airspeed............+10 / -5 knots*
Rate of Descent............<2000'—More than 2000 fpm
............<1000'—More than 1000 fpm*
............Inside FAF—>1000' fpm

Inside Final Approach Fix
- Localizer Deviation —1/3 dot deviation.........."COURSE"
- Glide Slope — ½ dot deviation.........."GLIDESLOPE"
- Non-ILS / RNAV (GPS / GNSS) deviation
  - — 1 Dot lateral course deviation.........."COURSE"
  - — ½ Scale on VDI (100' AFL or less).........."GLIDESLOPE"
- VOR deviation exceeds 2º.........."COURSE"
- NDB deviation exceeds 5 º.........."COURSE"
- LOC deviation exceeds ⅓ dot on PFD.........."COURSE"

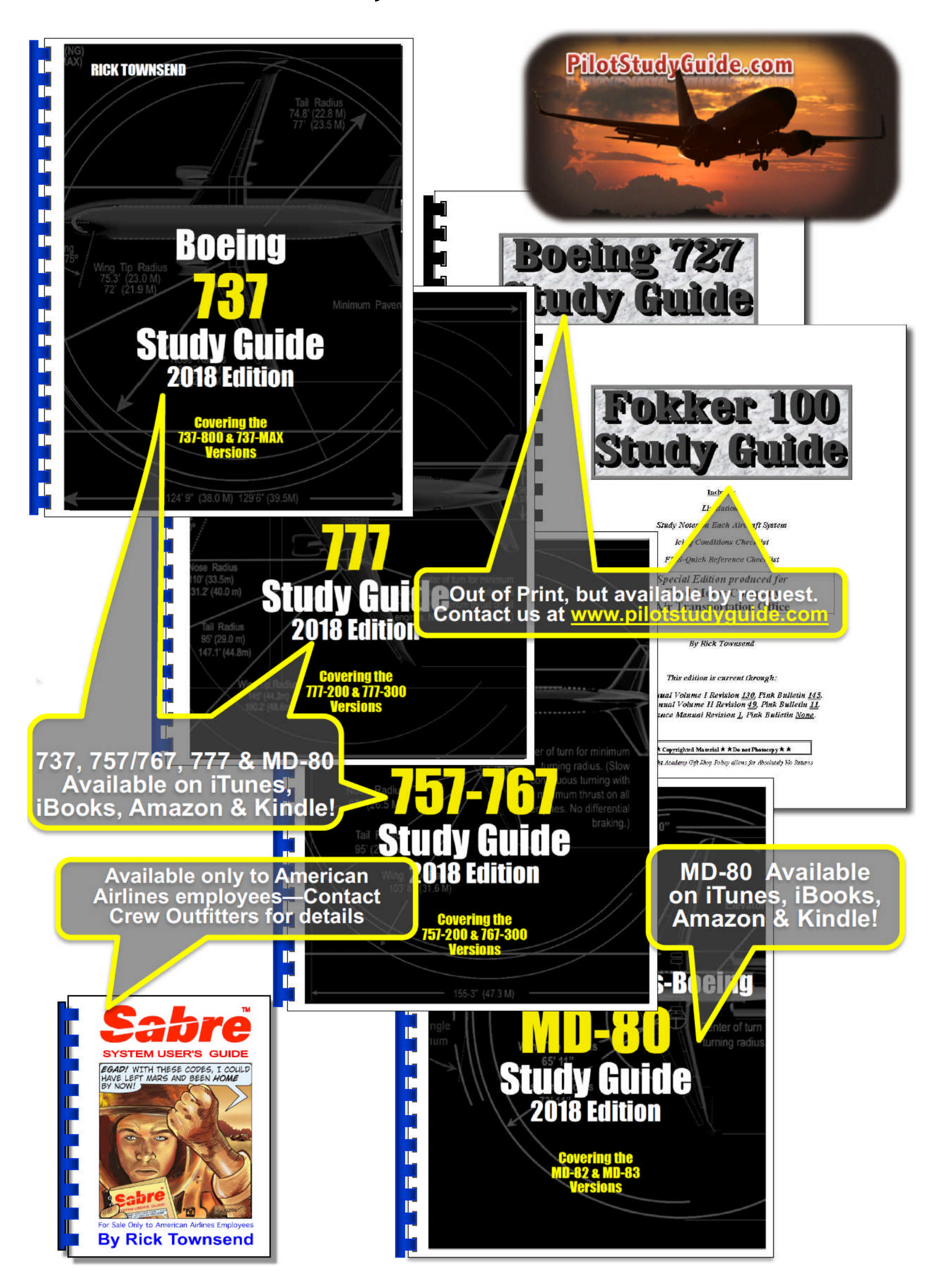
PM Directs "GO AROUND" if PF not correcting
APPROACH, LANDING, GO-AROUND 20.4-20.5

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www.kenyakidscan.org

Snowball Express



Serving the *children* of our fallen military heroes

Snowball Express Could Use Your Help!

Snowball Express honors America's fallen military service members who have made the ultimate sacrifice since 9/11 by

- **Humbly serving the families they left behind**
- **Championing their children's future success by creating opportunities for joy, friendship, and communal healing**
- **Connecting these families to one another.**

Since 2006, the mission of Snowball Express has been a simple, yet profoundly important one: Providing hope and new happy memories to the children of military fallen heroes who have died while on active duty since 9/11. In December each year we bring children together from all over the world for a four-day experience filled with fun activities, like sporting events, dances, amusement parks and more.

Nationally, Snowball Express provides comprehensive support programs for fallen families that are focused on transition and connections to community resources, healing and wellness, peer engagement, education and personal/professional development programs.

www.snowballexpress.org

The *McDonnell Douglas-Boeing MD-80 Study Guide* is a compilation of notes taken primarily from flight manuals, but also includes elements taken from class notes, computer-based training, and operational experience. It is intended for use by initial qualification crewmembers, and also for systems review prior to recurrent training or check rides.

The book is written in a way that organizes in one location all the buzz words, acronyms, and numbers the average pilot needs to know in order to get through qualification from an aircraft systems standpoint. The guide covers MD-82 and MD-83 series airplanes.

The author is a retired Air Force Fighter pilot with flight experience in seven different aircraft types including the F-101, F-106 and F-15, and instructional experience in the T-33, F-101 and AT-38B aircraft. He also consulted on the acquisition and development of the F-22 and helped to write the F-22 operating manual.

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